

FM 6-161 27 July 1978

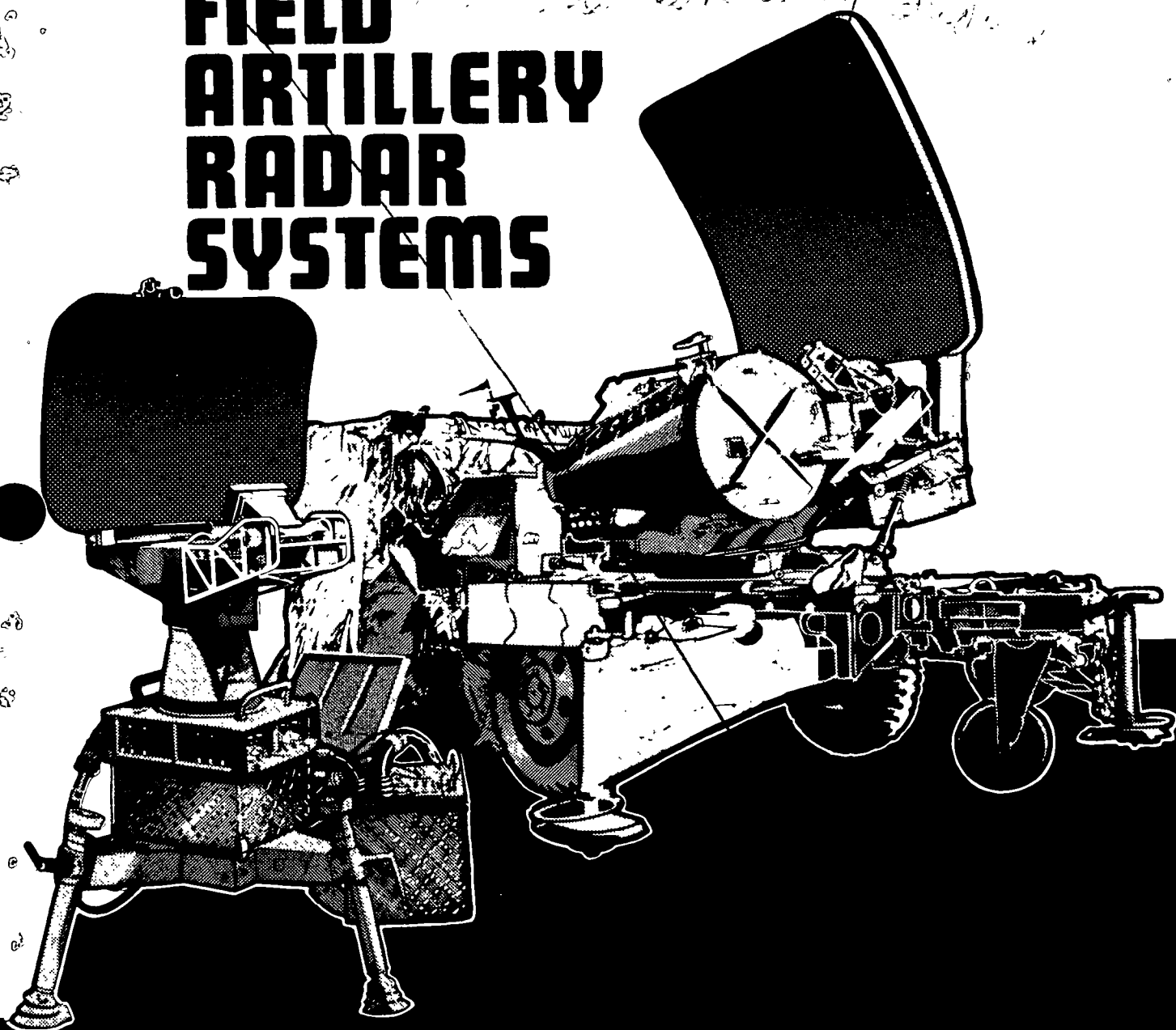
Reference

Chg 1

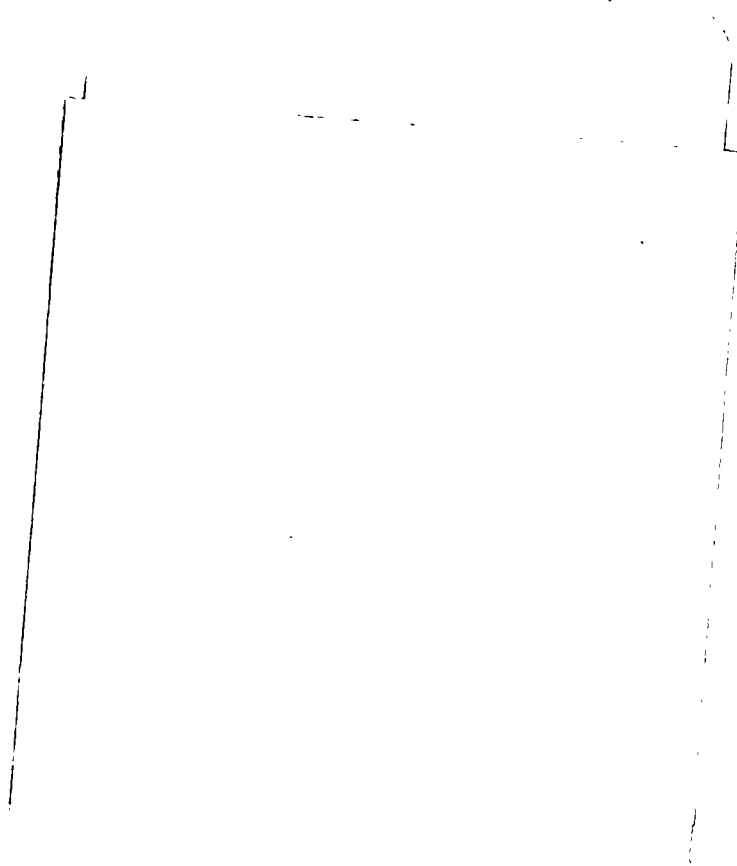
S/S Sept 7, 1980

FM 6-161

FIELD ARTILLERY RADAR SYSTEMS



HEADQUARTERS, DEPARTMENT OF THE ARMY



Reference

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Sept 7, 1984

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 10 April 1981

FIELD ARTILLERY RADAR SYSTEMS

FM 6-161, 27 July 1978, is changed as follows:

REMOVE

- ✓ i through iv
- ✓ 1-1 through 1-3
- ✓ 2-1 through 2-4
- ✓ 3-3 and 3-4
- ✓ 3-7 and 3-8
- ✓ 4-1 and 4-2
- ✓ 6-1 and 6-2

- ✓ A-1 through A-4

INSERT

- ✓ i through iv
- ✓ 1-1 through 1-3
- ✓ 2-1 through 2-4
- ✓ 3-3 and 3-4
- ✓ 3-7 and 3-8
- ✓ 4-1 and 4-2
- ✓ 6-1 through 6-14
- ✓ 7-1 through 7-14
- ✓ 8-1 and 8-2
- ✓ A-1 through A-4

3. File this change in the front of the publication for reference purposes.

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C1, FM 6-161

10 APRIL 1981

By Order of the Secretary of the Army:

E. C. MEYER

*General, United States Army
Chief of Staff*

Official:

J. C. PENNINGTON

*Major General, United States Army
The Adjutant General*

DISTRIBUTION:

Active Army, ARNG, and USAR: To be distributed in accordance with DA Form 12-11A, Requirements for Radar Set AN/MPQ-4A (Qty rqr block no. 76).

Additional copies can be requisitioned from the US Army Adjutant General Publications Center, 2800 Eastern Boulevard, Baltimore MD 21220.

Field Manual

No. 6-161

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 27 July 1978

FIELD ARTILLERY RADAR SYSTEMS

This manual, *used in conjunction with the appropriate operator TMs*, is a guide for employing field artillery radar systems. It is directed toward the radar operator and his direct supervisor(s). Only those subjects not appropriately covered in other manuals are included.

The material presented herein applies, without modification, to both nuclear and nonnuclear warfare.

Changes and Comments. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded directly to the Commandant, US Army Field Artillery School, ATTN: ★ ATSF-TD-TL, Fort Sill, Oklahoma 73503.

References. Related publications are listed in the appendix.



When used in this publication, "he," "him," "his," and "men" represent both the masculine and feminine genders.

★ FIELD ARTILLERY RADAR SYSTEMS

CHAPTER 1.	The Threat	1-1
CHAPTER 2.	Training	2-1
CHAPTER 3.	Weapons Locating Radar Set AN/MPQ-4A	3-1
SECTION I.	Organization	3-2
II.	Registration	3-3
III.	Radar Adjustment of Fire	3-21
IV.	Radar Survey	3-24
V.	Tactical Employment and Position Requirements	3-25
VI.	Operations Security	3-30
VII.	Airlifting the AN/MPQ-4A Radar and Ancillary Equipment	3-35

	Page
CHAPTER 4. Moving Target Locating Radar Set AN/TPS-25A	4-1
SECTION I. Organization and Operation	4-2
II. Tactical Employment and Position Requirements	4-3
III. Airlifting the AN/TPS-25A and Ancillary Equipment	4-15
 CHAPTER 5. Moving Target Locating Radar Set AN/TPS-58	5-1
SECTION I. Organization and Operation	5-1
II. Target Acquisition and Radar Gunnery	5-2
 CHAPTER 6. Firefinder Mortar Locating Radar Set AN/TPQ-36	6-1
SECTION I. Organization	6-2
II. Tactical Employment and Position Requirements	6-4
 CHAPTER 7. Firefinder Artillery Locating Radar Set AN/TPQ-37	7-1
SECTION I. Organization	7-3
II. Tactical Employment and Position Requirements	7-5
 CHAPTER 8. Decontamination of Equipment	8-1
 APPENDIX References	A-1

CHAPTER 1

THE THREAT

	Paragraph
Purpose and Scope	1-1
Characteristics of Field Artillery Radars	1-2
Operations Security Indicators	1-3
Countermeasures	1-4

1-1. Purpose and Scope

The purpose of this chapter is to describe the potential battlefield threat to radar survival and to identify the operational security indicators and equipment shortcomings that must be eliminated or controlled to reduce this vulnerability.

1-2. Characteristics of Field Artillery Radars

There are several tactical radars that have been designed specifically to meet the targeting needs of field artillery (i.e., enemy indirect fire weapons and moving target location). These radars have been categorized as weapons locating or moving target locating radars.

Weapons Locating Radars

The AN/MPQ-4A is the current US Army weapons locating radar. It has been designed to provide the coordinates of enemy indirect fire

weapons at ranges up to 15,000 meters with an accuracy of 0 to 200 meters, depending upon the trajectory of the enemy rounds. The radar uses two beams (upper and lower) to detect the round. As the round passes through each beam, a reflected signal is received at the radar set. The range and direction to each intercept point provide the radar's computer with the information needed to compute the coordinates of the firing piece or the impact of the round, depending upon which leg (ascending or descending) of the trajectory the radar observes.

★ *Firefinder Weapons Locating Radars*

The AN/TPQ-36 is compact, highly mobile, and designed for rapid deployment with front-line units. It provides fully automatic, fast, accurate locations of artillery, rockets, or mortars. It can handle simultaneous fire from weapons at multiple locations, detecting and specifying their positions on the first round. Friendly weapons can also be tracked, providing registration for more accurate initial fires and adjustment of fire.

The AN/TPQ-37 provides fully automatic, fast, accurate locations of long-range artillery and rockets. The AN/TPQ-37 needs only to track a projectile for a few seconds to derive a point of

origin. Therefore, multiple targets can be tracked simultaneously. Once targets are located by the radar, they are displayed for the operator to send to the tactical operations center. The AN/TPQ-37 may also provide registration and adjustment for friendly fires.

Moving Target Locating Radars

Moving target locating radars, such as the AN/TPS-25A and the AN/TPS-58, are designed to observe moving vehicles and personnel. Both the AN/TPS-25A and the AN/TPS-58 are doppler radars that provide the operator with the location of the target as well as some indication of the nature of the target (personnel, light truck, armored vehicles, etc.). The AN/TPS-58 is also capable of performing certain radar gunnery missions.

1-3. Operations Security Indicators

Operations security (OPSEC) is defined in AR 530-1 as the protection of military operations and activities through the identification and subsequent elimination or control of intelligence indicators that are susceptible to hostile exploitation. Indicators are anything that can be converted by the enemy into meaningful intelligence and are categorized as signatures, profiles, and patterns. Signatures are intelligence indicators that result from the presence of military equipment or personnel. Profiles are the indicators caused by the actions of a military unit. Patterns are the indicators caused by stereotyped actions.

Signatures can be controlled by the radar section. Profiles and patterns can be corrected only by the headquarters controlling the radars. This section will deal primarily with the signatures associated with FA radars. At the radar section level, little can be done to avoid operational patterns. Normally, FA radars are "cued" by the station they report to. It is the responsibility of commanders and staff officers to review employment procedures to reduce vulnerabilities arising from operational profiles and patterns.

There are four types of signatures—imagery, electromagnetic, olfactory, and sonic. The discussion below covers only the first two signature types, since radar sections are particularly vulnerable to exploitation through their imagery and electromagnetic signatures. FA radars present unique imagery and electromagnetic signatures. There are only a few FA radars within each division area of operations (in comparison to the number of other emitters within the division). Each radar can be tied to a field artillery command post (CP) at battalion or higher level through analysis of communications nets. Analysis of radar positions and the radio nets in which they operate can be the start point for an opposing force staff to break down the entire friendly artillery order of battle. This vulnerability must be kept in mind when employing FA radars.

IMAGERY SIGNATURES. The unique antennas on FA radar systems make them easy for imagery interpreters to recognize. This visual signature has to be overcome through careful use of terrain and camouflage techniques. The requirement to maintain electronic line of sight to the target or the enemy round (in the case of weapons locating radars) further complicates the problem of overcoming the visual signature problem. The radar, its generator, and associated vehicles produce large amounts of heat. This heat is the source of an infrared (IR) signature, which is another imagery signature. Care must be taken to reduce this signature through baffling or shielding. However, shielding, which significantly reduces the infrared signature, may well heat the equipment beyond its design limits, inducing equipment failure. On the other hand, an infrared signature behind the first hill can be fully exploited only by an aerial platform that goes over the radar position. This reduces, somewhat, a potential enemy's capability to exploit this signature.

ELECTROMAGNETIC SIGNATURE. Electromagnetic signature is normally what is envisioned when radar signature is discussed. An enormous amount of information can be gained from the analysis of a radar's signal. The radar's signal characteristics—frequency, bandwidth,

pulse width, and pulse repetition frequency—are unique to each type of radar. An enemy intercept operator can readily tell when he has an AN/MPQ-4A, an AN/TPS-25, or an AN/TPQ-58.

A potential enemy would use the technique of direction finding (DF) to locate radars. The information that cannot be gained from signal analysis is gained through direction finding. Direction finding is accomplished by monitoring an emitter with three or more receivers simultaneously. Each receiver is fitted with a steerable, highly directional antenna. The orientation of the antenna gives a line bearing to the receiver. The intersection of the three bearing lines gives the transmitter's location. This technique is used to locate both radios and radars. However, because of the physical characteristics of radio waves at various frequencies, improperly employed radars can be located within 50 to 100 meters; whereas, the location of a tactical radio set within 250 meters is considered highly accurate.

The radar's electromagnetic signature is its greatest vulnerability. Through signal analysis, enemy intercept operators can identify the type of radar employed. Knowledge of US

employment practices and organization tells the intercept operator which artillery organizations this radar section might report to (e.g., battalion FDC, div arty TOC). Direction finding of the radar signal would locate the radar set. Intercept and direction finding of the radar section's tactical radio key the intercept operator to the net in which the radar section is operating. The next step is to locate and find the direction of the station to which the radar section reports. Finally, by intercepting the many other nets an artillery headquarters must operate in and confirming that all of these emitters are tied to a single location, the command post location is confirmed. The association of radios and radars provides enemy intelligence analysts a lucrative source of information on the friendly forces order of battle.

1-4. Countermeasures

The actions that can be taken by the radar section to reduce its imagery and electromagnetic signatures (thereby increasing its survivability) are discussed in chapter 3, section VI, and ★ chapters 4, 5, 6, and 7, or in the applicable equipment technical manual.



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CHAPTER 2

TRAINING

	Paragraph
Purpose and Scope	2-1
Objective	2-2
Planning	2-3
Training Considerations	2-4
Conduct of Training	2-5
Training Resources	2-6
Summary	2-7

2-1. Purpose and Scope

The purpose of this chapter is to present the requirements for training the personnel of a radar section in the performance of their duties. It includes general and specific guidelines on how this training will be conducted.

2-2. Objective

The primary objective is to train the radar crewmen individually to meet the standards of ★ Soldier's Manual FM 6-17B or FM 6-13R and the radar sections collectively to meet those outlined in ARTEP 6-307, with combat effectiveness as an

end result. Once attained, this proficiency level can be maintained only by frequent, imaginative, and meaningful follow-on training.

2-3. Planning

Evaluation

The first step in the planning process is to evaluate the section/individual training strengths and weaknesses as they relate to the tasks identified in the ARTEP. The results of this evaluation process are the basis for the development of a training program. The training objective, identified during evaluation, must then be prioritized and incorporated into the platoon's individual and section training plan.

Resource Requirements

The next step is to insure that all existing or required resources are available to conduct a successful training program. These include:

INSTRUCTORS.

EQUIPMENT.

TRAINING AIDS (e.g., SIMULATORS AND FILMS).

TRAINING AREA/ENVIRONMENT.

TIME.

EXTERNAL SUPPORT (e.g., LIVE FIRE AND COMMUNICATIONS).

The end result of training—individual and collective—is combat effectiveness.

Alternatives

Finally, it is necessary to provide for a fallback position if the optimum training plan cannot be implemented. The one factor that will disrupt training the most is the nonavailability of radar personnel or equipment as the result of unscheduled commitments. Another is changes in the weather conditions. In any event, careful planning that provides an alternative to continue training under other than optimum conditions is essential if the overall program is to succeed. Trainers must use every available precious resource and every training opportunity offered to maintain and enhance the combat readiness of personnel and sections.

2-4. Training Considerations

The only limiting factor to the success or failure of a training program is the imagination and ingenuity of the trainer. He must conduct a flexible and realistic program oriented toward performance, rather than procedure, with a built-in system of periodic evaluations to measure and modify the program as required.

The program should include training at the lowest level identified in the evaluation process.

As individual crewmen become proficient, section training must follow to integrate the individual skills into the collective effort. Multilevel training should be conducted concurrently whenever possible.

Every opportunity to conduct or participate in training must be thoroughly investigated to insure that maximum use is made of available training resources. Integrated training commitments to support division artillery units with radar sections are particularly desirable and necessary to develop proficiency in working with the fire direction center (FDC) and tactical operations center (TOC) and should be energetically solicited and accepted whenever they are offered.

The impact of training cost must be considered in light of an always austere budgetary environment and, more importantly, conservation of the limited supplies available. Maximum training must be accomplished with each live round fired. In all cases, training devices or simulators should be used whenever live fire support is not required.

2-5. Conduct of Training

Training will be conducted in accordance with TC 21-5-7 and FM 21-6. The goal of training must be the standards set forth in AR 611-201, ★ARTEP 6-307, and Soldier's Manuals FM 6-17B and FM 6-13R.

Normally, individual training is conducted by noncommissioned officers, as far as practicable. Officers are responsible for preparing training plans, for conducting unit training, and for supervising and testing individual training.

An informal record, reflecting all training received by each individual in the section, is maintained by the section chief or the field artillery radar technician. This record shows each period of instruction attended, tests taken, and pertinent remarks that describe the training status of the individual. Collectively, these individual records serve as a ready reference to determine the radar section's status of training.

2-6. Training Resources

The soldier's manual (SM) is a field manual for the individual soldier that defines for him in "real world" terms what the Army requires him to know and do throughout his career in his MOS. Soldier's manuals provide individual tasks, conditions, standards, and the references that apply and are the prime source from which skill qualification tests (SQT) are developed.

The commander's manual (CM) provides a complete list of critical tasks for each MOS from skill level 1 to 4. The list identifies tasks, gives references, and indicates where a soldier is trained for the task. Commander's manuals are an invaluable aid for both trainers and managers.

The skill qualification test determines the soldier's proficiency at his current skill level and his qualifications for advancement to the next higher skill level. The skill qualification test emphasizes hands-on performance rather than written tests. Using SQT results, the training manager and trainer can determine individual training weaknesses.

Training support material includes:

FIELD ARTILLERY CATALOG OF INSTRUCTIONAL MATERIAL. This document is published annually and contains a listing of all instructional material available for issue to units in the field. Requests for copies of the catalog should be addressed to: Commandant, US Army Field Artillery School, ATTN: ATSF-CR-TS, Fort Sill, OK 73503.

★ **FIELD ARTILLERY RADAR CREWMAN INSTRUCTIONAL PACKET.** This is a packet of training material to supplement training of MOSs 17B10/20 and 13R10/20 and is available from the same source as that listed above.

The Training and Audiovisual Support Center (TASC) can provide the training manager and the trainer all types of audiovisual aids, graphic training aids, training devices, training room support items, and training equipment. Each TASC publishes a catalog that lists what is available and gives instructions on how to request the items.

MORTAR LOCATING RADAR TARGET SIMULATOR AN/TPA-7 (TASO DEVICE NO: DVC X15B1). Use of this training device is the most effective method of conducting weapons locating and gunnery training on the AN/MPQ-4A when live fire support is not available.

TRAINER, RADAR, AN/ULT-T5 (TASO DEVICE NO: DVC 11-35). Operating the AN/MPQ-4A radar set in an electronic warfare environment involves special preparatory training. The radar crewman must actually experience the jamming and interference signals to develop proficiency in recognition and application of remedial techniques. This device generates all of the various electronic countermeasure (ECM) signals encountered and emphasizes the existence of a hostile environment.

COUNTERMEASURES TRAINING SIGNAL TRANSMITTING SET AN/ULT-T2 (TASO DEVICE NO: DVC 11-7). This simulator performs the same functions for the radar set AN/TPS-25A as the AN/ULT-T5 does for the AN/MPQ-4A.

★ **TRAINING DEVICES FOR AN/TPQ-36 AND -37.** The AN/TPQ-36 and AN/TPQ-37 radar systems have embedded training devices, and

either can be initialized from the operational program tape.

2-7. Summary

It is an established fact that one of the dividends of a vigorous, realistic, and effective training program is an increased ability to survive during combat operations. Exceptional single-mindedness of purpose, innovativeness, and tenacity are required to overcome the many obstacles that may delay, defer, or dilute the best laid plans for conducting radar training.

Two of the most important factors to be considered when determining a radar section's ability to survive during hostile environment operations are its proficiency in, and the degree of discipline it demonstrates toward, security, camouflage, and electronic counter-countermeasures. These essential elements must be incorporated into every training exercise to the greatest degree possible. The radar section must not be allowed to become complacent in training, or they may not survive in combat.

**Radar-related devices
normally available at
TASC:**

**AN/TPA-7
AN/ULT-T5
AN/ULT-T2**

CHAPTER 3

WEAPONS LOCATING RADAR SET AN/MPQ-4A

Section I. Organization

Organization of AN/MPQ-4A
Radar Section 3-1

Duties of Personnel 3-2

Organization of Personnel
for Operation 3-3

Section II. Registration

Purpose 3-4

Radar as the Observer 3-5

Radar-Observed High-Burst
Registration 3-6

Marking and Strobing Target Echoes for
High-Burst Registration 3-7

Conduct of a High-Burst Registration 3-8

Radar-Observed Mean-Point-of-Impact
Registration 3-9

Marking and Strobing Target Echoes for
Mean-Point-of-Impact Registration 3-10

Conduct of Mean-Point-of-Impact
Registration 3-11

Section III. Radar Adjustment of Fire

General 3-12

Fire Adjustment Principles
Pertinent to Radar 3-13

Target Location Information 3-14

Call for Fire 3-15

Message to Observer 3-16

Radar Considerations 3-17

Subsequent Corrections 3-18

Procedure for Adjusting Fire 3-19

Section IV. Radar Survey

General 3-20

Conduct of a Radar Survey 3-21

Section V. Tactical Employment and Position Requirements

Tactical Missions 3-22

Selection of Site	3-23
Tactical Considerations	3-24
Technical Considerations	3-25
Site Evaluation	3-26

Section VI. Operations Security

Countermeasures	3-27
Jamming	3-28

Section VII. Airlifting the AN/MPQ-4A Radar and Ancillary Equipment

General	3-29
Preparing the Radar Trailer	3-30
Rigging the Radar Trailer	3-31
Preparing the Generator Trailer	3-32
Rigging the Generator Trailer	3-33
Preparing the ¼-Ton Trailer	3-34
Derigging the Radar and Generator Trailers	3-35

Section I. ORGANIZATION

3-1. Organization of AN/MPQ-4A Radar Section

There are five AN/MPQ-4A radar sets in each target acquisition battery. Normally, the radars are allocated to field artillery battalions by the division artillery tactical operation center (TOC) as dictated by the command guidance, the terrain, and the enemy situation. The field artillery battalion will site and control the operation of the radar to provide the coverage directed by the TOC. To reduce the radar's vulnerability (it is an active transmitter) and increase its effectiveness, the radar should be oriented and cued only when and where enemy weapons are firing. The division artillery TOC may direct that any or all radars be oriented toward different areas of the battlefield if the situation so warrants.

3-2. Duties of Personnel

The principal duties of personnel of the AN/MPQ-4A radar section of a target acquisition battery are listed below.

Radar Technician

Advises the commander and staff on equipment capabilities and employment. Performs reconnaissance to determine actual site. Coordinates the activities of all radar personnel in their respective duties.

Section Chief

Supervises operation and operator maintenance of the radar equipment, assists the radar technician, and evaluates the radar site after occupation of position.

★ Field Artillery Radar Repairer

Performs organizational maintenance of radar equipment and assists the radar technician.

Senior Field Artillery Radar Operator

Operates and supervises the operation of the radar set, assists in the emplacement and concealment of the radar position, and assists the section chief in all of his duties.

Radar Operator

Operates the radar and the computer, using the controls of the control-indicator group.

Sets up the radar chart on a grid sheet, determines the altitudes of the weapon locations from a contour map, plots the final locations, and keeps the necessary records.

Operates the radar's prime movers and performs scheduled maintenance on the prime movers. Provides local security and performs other duties assigned by the chief of the section.

Operates, and performs user maintenance on, communications equipment utilized in the radar section.

Power Generator Operator/Mechanic

Operates and performs operator and organizational maintenance on the power generator; provides local security; and assists in the operation of the radar set during periods of intense enemy weapons activity.

3-3. Organization of Personnel for Operation

A well-trained radar crew is essential to insure accurate and timely locations of hostile weapons. Continuous operation may be required during combat; therefore, every man in the section must be capable of performing each of the duties necessary to obtain and process hostile weapon locations.

During continuous operation, the section should be organized into three-man teams, excluding the chief of section and the radar **★**repairer, who are on call continuously. These three-man teams must consist of a radar operator, a radar plotter, and a generator operator.

To prevent fatigue and eyestrain, the members of the team should alternate their duties so that no one member serves as the control unit operator more than 30 minutes at a time. When the teams are changed, the personnel on duty should be relieved one at a time. This will allow each person to become familiar with the situation as he assumes his duty, since he will be working with two men who are already familiar with the situation.

Note. Weapon location procedures are found in TM 11-5840-208-10.

Section II. REGISTRATION**3-4. Purpose**

The firing tables used by field artillery units are based on a set of standard conditions of weather and materiel. If all conditions of weather and materiel are standard and there are no errors in survey or in the firing chart, a projectile will achieve the standard range defined in the

appropriate firing table and burst on the gun-target line. However, standard conditions of weather and materiel seldom exist simultaneously; therefore, a projectile rarely (if ever) hits the target when a weapon is fired with only standard firing table data. Nonstandard atmospheric conditions, nonstandard materiel, or errors in survey or in the firing chart may cause inaccuracy in firing.

Notes.

1. (High burst only) The telescope must be oriented to the pointing azimuth. To accomplish this, place the DETENT switch in the AZIMUTH ORIENT position. Apply (add or subtract as necessary) the field correction to the chart azimuth. Then move the antenna in azimuth until the AZIMUTH counter indicates the corrected value. Record the chart azimuth in block 6 of DA Form 2888.
2. If the burst from the first round appears above the horizon but is not seen on the B-scope, the pointing angle of elevation must be changed to cause the next round to burst in the radar beam. The antenna also may have to be moved in azimuth to cause the burst to appear in the center of the telescope. When the antenna is moved in azimuth or elevation, the new pointing data must be entered in the appropriate block under step 2 of DA Form 2888. If the first round bursts more than 5 miles below the center of the telescope, the FDC must be notified (BURST TOO LOW, REQUEST SITE (altitude) INCREASE). The antenna should never be lowered in elevation.
3. (High burst only) If the B-scope azimuth disagrees with the telescope azimuth more than -10 mils, an error has been made in spotting, marking, or strobing the echo on the B-scope. Therefore, the data to the round will not be valid.
4. The average azimuth, range, and altitude must be computed independently by two crewmembers. Insert the average azimuth and range into the computer. Record the resulting grid coordinates in block 41, DA Form 2888. Polar-plot the average range and azimuth on the radar chart and record the resulting grid coordinates. These two sets of coordinates should agree with each other within 20 meters in easting and 20 meters in northing.

RADAR OBSERVED HIGH-BURST OR MEAN POINT-OF-IMPACT (DATUM PLANE) REGISTRATION For use of this form, see FM 6-161 the proponent agency is TRADOC				SEE NOTES ON REVERSE	
STEP 1 MESSAGE TO OBSERVER		STEP 2 INITIAL POINTING DATA		STEP 3 INITIAL REGISTRATION POINT ALTITUDE	
1 OBSERVE (Check applicable box) ☒ HB ☐ MPI		6. AZ (Nearest 1 mil) (Note 1) 1634 + 45 = 1679		11. MAP ALTITUDE (340 + 50 meters) = 390	
2 FOR (Unit or call sign) Z 4842		7. RANGE (Nearest 10 meters) 6110		12. RANGE (7) (in thousands) 6.11	
3 AT GRID 6400 3900		8. ELEV TO SC CR 16		13. ELEVATION (ID) 26	
4 REPORT ALTITUDE		9. +10 MIL + 10		14. VI (12 x 13) 159	
5 REPORT WHEN READY TO OBSERVE		10. ELEV (Nearest 1 mil) (8 + 9) 26 + 7 = 33		15. ALTITUDE (RADAR) (Meters) 326	
				16. ALTITUDE (RP) (14 + 15) 485	
STEP 4. REPORT TO FDC					
ALTITUDE (16 or 11 whichever is the greater) 485					
AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE					
STEP 5 RECORDING AND COMPUTATION					
ROUND NO	FROM B SCOPE		FROM TELESCOPE (HIGH BURST ONLY)		
	RANGE	AZIMUTH	AZIMUTH DEVIATION (Note 3)		ELEVATION DEVIATION
			LEFT (-)	RIGHT (+)	BELOW (-) ABOVE (+)
1	6300	1675	0 45		0 7
IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 6 AND 10 (Note 2)					
2	6280	1675	4		6
3	6250	1672	5		5
4	6340	1680	7		1
5	6320	1677	25		0
6	6290	1675	7		2
7	6000	1650	25		19
8	6220	1680	7		6
TOTAL	17 37680	18	TOTAL LEFT (-) - 7	TOTAL RIGHT (+) + 23	TOTAL BELOW (-) - 19 TOTAL ABOVE (+) + 1
NOTE AFTER SIX VALID ROUNDS REPORT 'END OF MISSION' TO FDC			19. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (-) AND RIGHT (+) + 16		20. ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (-) AND ABOVE (+) - 18
23. REGISTRATION POINT RANGE (Nearest 10 meters) 6280 6 37680 (17) 6280		24. AZIMUTH OF MPI (Nearest 1 mil) NOT USED		21. 2.6 6 + 16 (19) 25 (21) + 3 26 (6) 1679 29. HB AZ (Algebraically add 25 and 26) 1682	
				22. 3 6 - 18 (20) 27 (22) - 3 28 (ID) 33 30. HB ELEV (Algebraically add 27 and 28) 30	
STEP 6 FINAL REGISTRATION POINT ALTITUDE			STEP 7 REPORT TO FDC		
31. RP RG (23) (in thousands) 6.280			36. REPORT ON RADAR OBSERVED (Check applicable box) ☒ HB ☐ MPI		
32. HB (Enter value block (3D)) MPI (Enter value block (ID)) 30			37. TIME OBSERVED 261500		
33. VI (31 x 32) 188			38. AZIMUTH (MPI (24) HB (29)) (See note 4) 1682		
34. ALTITUDE RADAR 326			39. RANGE (23) (See note 4) 6280		
35. ALTITUDE RP (33 + 34) 514			40. ALTITUDE (35) (See note 4) 514		
			41. GRID OF RP (Nearest 10 meters) 6414 3866		

DA FORM 2888
1 MAY 75

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

Figure 3-1. DA Form 2888 showing a completed high-burst registration.

FOLDOUT FOR FIGURE 3-1, DA FORM 2888.
THIS FORM SHOULD REMAIN VISIBLE FOR
REFERENCE THROUGHOUT SECTION II.

The distance by which a projectile misses the target is caused by the combined effects of these errors. The total error and the corrections for it can be determined by registration.

In order to determine the corrections to compensate for nonstandard conditions, it is necessary to know where the rounds did hit when they were fired with a certain deflection, fuze setting, and quadrant elevation. The "did hit" location can be compared with the location where the rounds should have hit if all conditions had been standard. The difference between the "should hit" location and the "did hit" location can be converted to corrections by established procedures.

Normally, a mean-point-of-impact (MPI) or high burst (HB) radar registration is faster and more economical than a precision registration conducted by a ground observer. From six usable observed rounds fired in a high-burst registration, the fire direction center (FDC) can determine the corrections to the firing data for deflection, fuze setting, and quadrant elevation. In a mean-point-of-impact registration, the same number of usable rounds are fired, but point-detonating fuzes are used; therefore, a correction for the fuze setting cannot be obtained. Normally, the FDC will fire a high-burst registration when the mechanical time fuze is available and its use is anticipated for subsequent fire missions in the area. (Registration may be conducted using only three usable rounds as determined by the fire direction officer (FDO).)

3-5. Radar as the Observer

The AN/MPQ-4A radar section is often required to observe high-burst and mean-point-of-impact registrations. The radar section should have direct communications with the FDC at all times. The radar section can complete a registration quickly, even during periods of poor visibility when ground observation is ineffective.

The radar visibility diagram (para 3-26) is used by the fire direction officer to select a suitable location for the registration. Initially, using the visibility diagram, he selects an observable area within range of the radar; a suitable altitude can then be determined by checking the screening crest profile.

3-6. Radar-Observed High-Burst Registration

A high-burst registration is fired with a mechanical time fuze. The burst must be high enough in space so that it can be observed through the optical telescope. The radar section is alerted to observe a high-burst registration by a message to observer. This message must be prepared by the FDC and sent to the radar sections. The radar section immediately plots the coordinates announced in the message to observer.

Message to Observer (Step 1, DA Form 2888, Figure 3-1)

The message to observer, which is a standard message, consists of five elements and should be transmitted to the radar section in the following sequence:

WARNING ORDER. The first element must always be sent. It consists of the order OBSERVE HIGH BURST. This warning order informs the radar section of the type of registration to be fired and directs the radar crew to immediately begin preparations to observe.

UNIT TO FIRE. The second element consists of the word FOR followed by the call sign or code name of the unit to fire. The second element may be omitted by SOP when it is unnecessary for the radar section to contact the battery that is to fire or to know the battery location.

LOCATION. The third element consists of the word GRID followed by the grid coordinates. It specifies the military grid reference (to the nearest 10 meters) to the point to which data are obtained. The third element must always be sent.

ALTITUDE REPORT. The fourth element consists of the words REPORT ALTITUDE. It requires the radar section to report the altitude of the high burst to the fire direction center.

REPORT ORDER. The fifth element consists of the words REPORT WHEN READY TO OBSERVE.

Use of DA Form 2888

The message to observer received by the radar section is copied in the block marked STEP 1: MESSAGE TO OBSERVER, on DA Form 2888, Radar Observed High-Burst or Mean-Point-Of-Impact (Datum Plane) Registration (figure 3-1). DA Form 2888 is available through normal publication channels.

Initial Pointing Data (Step 2, DA Form 2888, Figure 3-1)

The radar plotter determines the pointing azimuth and pointing range, which are the direction and distance from the radar to the announced location of the high burst. The angle of elevation to the screening crest along the pointing azimuth is determined by observation through

STEP 1: MESSAGE TO OBSERVER	
1. OBSERVE (Check applicable box)	☒ HB ☐ MPI
2. FOR (Unit or call sign)	Z 4 B 42
3. AT GRID	6400 3900
4. REPORT ALTITUDE	
5. REPORT WHEN READY TO OBSERVE	

STEP 2. INITIAL POINTING DATA	
6. AZ (Nearest 1 mil) (Note 1)	1639 + 45 = 1679
7. RANGE (Nearest 10 meters)	6110
8. ELEV TO SC CR	16
9. +10 MIL	+ 10
10. ELEV (Nearest 1 mil) (8 + 9)	26 + 7 = 33

the telescope (at 0 mils elevation) or from the screening crest profile. Pointing elevation is then computed by adding 10 mils to the angle of elevation to the screening crest.

Note. Usually, 50 meters above the ground is a minimum height of burst for a high-burst registration.

Initial Registration Point Altitude (Step 3, DA Form 2888, Figure 3-1)

In order to complete the computations of firing data to send to the battery to fire, the FDC must know the altitude of the announced high burst. Therefore, as soon as the radar plotter has computed the pointing data, he determines the altitude and transmits it to the fire direction center. The altitude of the point selected for a high-burst registration is computed on DA Form 2888 and is determined in the following manner:

Multiply the pointing range (divided by 1,000 to the nearest 10 meters) by the pointing elevation. The product is the vertical interval between the radar and the high burst in meters. This step may be performed by simple multiplication in the space provided on the registration form.

Add the vertical interval obtained in the step above to the altitude of the radar in meters. The sum is the predicted altitude of the announced high-burst location.

STEP 3: INITIAL REGISTRATION POINT ALTITUDE	
11. MAP ALTITUDE	340 + 50 meters = 390
12. RANGE (7) (in thousands)	6.11
13. ELEVATION (10)	26
14. VI (12 x 13)	159

If the predicted altitude is below the map altitude plus 50 meters, use the map altitude plus 50 meters. However, a new pointing elevation must be computed to point the radar antenna at the minimum acceptable altitude. This computation is performed in the following manner:

Algebraically subtract the altitude of the radar from the map altitude plus 50 meters. The difference is the vertical interval.

Divide the vertical interval by the pointing range (divided by 1,000 to the nearest 10 meters). The result is the angle of elevation. This value rounded to the nearest mil is the new pointing elevation.

STEP 4: REPORT TO FDC						
ALTITUDE (16 or 11 whichever is the greater) 485						
AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE						
STEP 5: RECORDING AND COMPUTATION						
ROUND NO	FROM B SCOPE		FROM TELESCOPE (HIGH BURST ONLY)			
	RANGE	AZIMUTH	AZIMUTH DEVIATION (Note 3)		ELEVATION DEVIATION	
			LEFT (-)	RIGHT (+)	BELOW (-)	ABOVE (+)
1	6300	1675	0	75	0	7

IF REQUIRED, ADJUST POINTING DATA

Report to FDC (Step 4, DA Form 2888, Figure 3-1)

When the radar section has completed all preparations to observe the registration, the message ALTITUDE (so much), AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE is sent to the fire direction center. This message informs the FDC of several things. First, it informs the FDC of the altitude of the burst. Second, it notifies the FDC that the radar section will control the firing (the term AT MY

COMMAND means that the weapon will fire at the command of the radar section). Third, the term REQUEST SPLASH notifies the FDC that the radar section requires a 10-second alert prior to the burst of the round. Finally, it informs the FDC that the section is ready to observe the registration.

Note. When conducting a radar registration, the transmitter will not be fired until the FDC gives the 10-second warning SPLASH. After marking the target echoes, turn the transmitter off, then strobe.

Conduct of Fire

When the radar section is notified that the weapon is ready to fire, the radar plotter sends the command to fire the first round. When the weapon has fired, the FDC transmits SHOT, OVER to the radar section. The radar plotter acknowledges this report by transmitting SHOT, OUT to the fire direction center. Ten seconds before the round is due to burst, the FDC transmits SPLASH, OVER to the radar section. The radar plotter acknowledges this report by transmitting SPLASH, OUT to the fire direction center. When the radar section is ready for another round, it sends the command REPEAT to the fire direction center. The first round fired in a high-burst registration normally is considered an orienting round, and the radar crew may have to reorient the antenna on the actual burst point of the round. If it is necessary to reorient the antenna, the command REPEAT is delayed until the antenna has been reoriented and until after the previous round is recorded. The antenna is then reoriented to the actual burst point of the round. **THIS ROUND IS NOW CONSIDERED A VALID ROUND WITH 0-0 ERROR**, and the initial pointing data are changed to reflect the new pointing data.

Criteria for Use of Rounds

This procedure is continued until the radar section has observed and recorded on DA Form 2888 the data for six usable rounds. Usable rounds should burst within 50 meters of the rest of the rounds.

Location of High Burst

The radar can provide the location of the high burst either by grid coordinates and altitude; by direction, distance, and altitude from the radar to the high burst; or by direction, distance, and vertical angle to each round of the high burst. There is no difference in the accuracy of these three methods; however, the coordinates and altitude method is fastest because it does not require that the radar be plotted on the firing chart, and it is the preferred method of reporting. After the registration has been observed and any erratic round has been eliminated, the radar section transmits END OF MISSION to the fire direction center.

Note. Direction, distance, and altitude must *not* be sent in the clear.

Note 1.

(High burst only) The telescope must be oriented to the pointing azimuth. To accomplish this, place the DETENT switch in the AZIMUTH ORIENT position. Apply (add or subtract as necessary) the field correction to the chart azimuth. Then move the antenna in azimuth until the AZIMUTH counter indicates the corrected value. Record the chart azimuth in block 6 of DA Form 2888.

STEP 2: INITIAL POINTING DATA

6. AZ (Nearest 1 mil) (Note 1)

$1634 + 45 = 1679$

7. RANGE (Nearest 10 meters)

6110

8. ELEV TO SC CR

16

9. +10 MIL

$+10$

10 ELEV (Nearest 1mil) $(8 + 9)$

$26 + 7 = 33$

IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 6 AND 10 (Note 2)						
2	6280	1675		4	6	
3	6250	1672		5	5	
4	6340	1680		7		1
5	6320	1677		25	0	
6	6290	1675		7	2	
7	6000	1650	25			19
8	6220	1680		7	6	
TOTAL	17. 37680	18	TOTAL LEFT (-) -7	TOTAL RIGHT (+) +23	TOTAL BELOW (-) -19	TOTAL ABOVE (+) +1
NOTE AFTER SIX VALID ROUNDS REPORT "END OF MISSION" TO FDC			19 AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (-) AND RIGHT (+)		20 ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (-) AND ABOVE (+)	

★ Note 2.

If the burst from the first round appears above the horizon, but is not seen on the B-scope, the pointing angle of elevation must be changed to cause the next round to burst in the radar beam. The antenna also may have to be moved in azimuth to cause the burst to appear in the center of the telescope. When the

antenna is moved in azimuth or elevation, the new pointing data must be entered in the appropriate block under step 2 of DA Form 2888. If the first round bursts more than 5 mils below the center of the telescope, the FDC must be notified (BURST TOO LOW, REQUEST SITE (altitude) INCREASE OF ____ MILS). The antenna should never be lowered in elevation.

Note 3.

(High burst only) If the B-scope azimuth disagrees with the telescope azimuth more than -10 mils, an error has been made in spotting, marking, or strobing the echo on the B-scope. Therefore, the data to the round will not be valid.

AZIMUTH DEVIATION (Note 3)	
LEFT (-)	RIGHT (+)
0	45

Note 4.

The average azimuth, range, and altitude must be computed independently by two crewmembers. Insert the average azimuth and range into the computer. Record the resulting grid coordinates in block 41, DA Form 2888. Polar-plot the average range and azimuth on the radar chart and record the resulting grid coordinates. These two sets of coordinates should agree with each other within 20 meters in easting and 20 meters in northing.

38 AZIMUTH (MPI (24) HB (29)) (See note 4)	1682
39 RANGE (23) (See note 4)	6280
40 ALTITUDE (35) (See note 4)	514
41 GRID OF RP (Nearest 10 meters)	6414 3866

3-7. Marking and Strobing Target Echoes for High-Burst Registration

The success of any radar-observed registration depends on the accuracy of the marking and strobing of the target echo on the B-scope. In a high-burst registration, the range and azimuth are determined by strobing. Azimuth strobing provides a check on the azimuth deviations reported by the telescope observer.

A high-burst round is not considered valid unless the initial echo appears as shown in figure

3-3. Adjustments of the pointing elevation must be continued until the correct presentation appears.

The operator must know the point at which to mark and strobe the presentation to locate the burst point. The echo for a round fired in a high-burst registration first appears on the B-scope as shown in figure 3-2. It is then marked and strobed as shown in figures 3-3 and 3-4.

Note. In order to insure an accurate mark, the B-scope GAIN and INTENSITY controls must be properly adjusted.

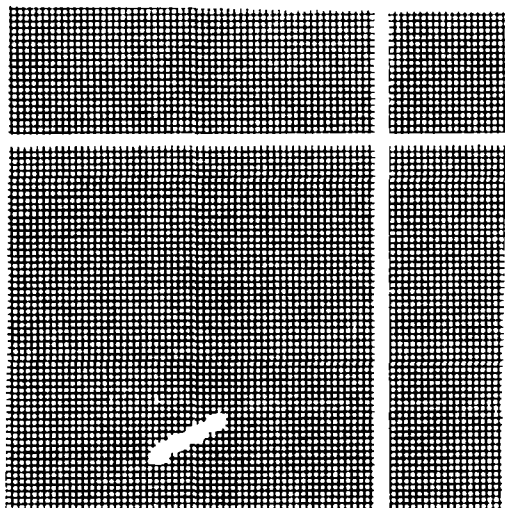


Figure 3-2. Projectile first entering the beam (HB).

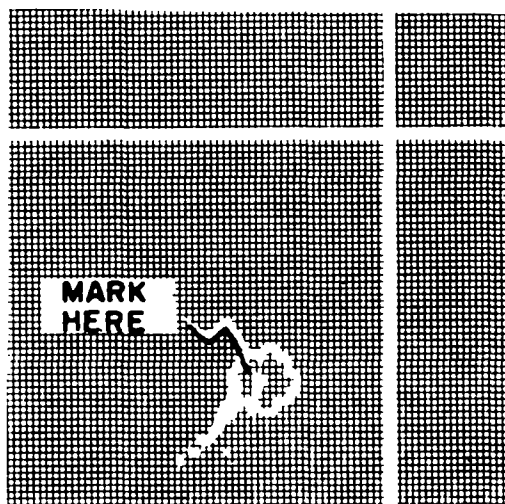


Figure 3-3. Projectile bursting in the beam (HB).

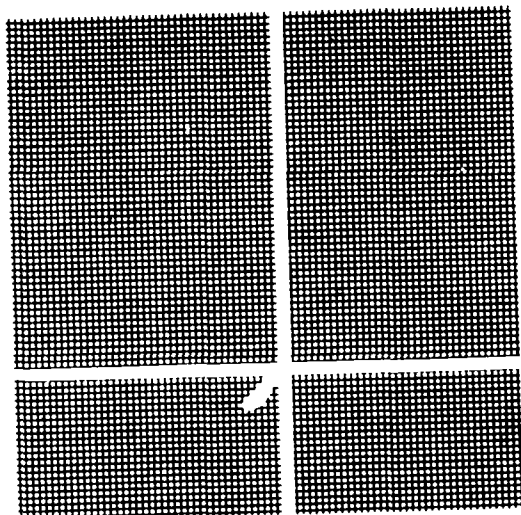


Figure 3-4. Strobing a marked burst (HB).

3-8. Conduct of a High-Burst Registration

Before the radar set can be considered ready to observe a registration, it must be emplaced and checked by the most accurate procedures possible. A registration can be accurately observed only if the radar set has been leveled, collimated, oriented, and range-calibrated and if the accuracy of the computer has been verified. All performance checks must be within the prescribed tolerances.

Note. The preregistration radar checks must be performed with the antenna pointed to the rear of the FEBA and at minimum elevation.

Personnel

Four members of the radar section are needed to conduct a radar-observed high-burst registration. Their duty assignments are:

CONTROL UNIT OPERATOR.

RADAR PLOTTER.

TELESCOPE OBSERVER.

RECORDER.

Sequence

When the radar section receives the message to observe, all members of the section start preparations immediately. A detailed explanation of the duties of each member is given for each of the following phases of the registration:

- ① PREPARATION.
- ② REORIENTATION.
- ③ OBSERVATION.
- ④ COMPUTATION.
- ⑤ REPORTING.

① Preparation

The preparation phase begins when the radar section receives the message to observer and ends when the section reports READY TO OBSERVE. An example problem, used to explain the duties of personnel, is shown on the DA

STEP 1: MESSAGE TO OBSERVER	
1. OBSERVE (Check applicable box)	☒ HB ☐ MPI
2. FOR (Unit or call sign)	Z 4B42
3. AT GRID	6400 3900
4. REPORT ALTITUDE	
5. REPORT WHEN READY TO OBSERVE	

Form 2888 in figure 3-1. The notes on the reverse side of DA Form 2888 (foldout) should be reviewed before proceeding. The duties of personnel during the preparation phase are outlined below.

THE RADAR PLOTTER—

- Records the message to observer in step 1 on DA Form 2888, as shown in figure 3-1.
- Plots the coordinates given in the message to observer on the radar chart.
- Measures the azimuth and range to the announced high-burst location and announces aloud the following data: AZIMUTH 1634 (always read to the nearest mil), RANGE 6110 (always read to the nearest 10 meters).
- Records the announced azimuth and range as the pointing azimuth and range in blocks 6 and 7 on the registration form.
- Records in block 8 the screening crest elevation at the pointing azimuth as indicated on the screening crest profile. He adds to the angle of elevation the 10 mils already recorded in block 9 and records the sum (to the nearest mil) in block 10 as the pointing elevation.

STEP 2: INITIAL POINTING DATA	
6. AZ (Nearest 1 mil) (Note 1)	1634 + 45 = 1679
7. RANGE (Nearest 10 meters)	6110
8. ELEV TO SC CR	16
9. +10 MIL	+ 10
10. ELEV (Nearest 1 mil) (8 + 9)	26 + 7 = 33

Note. At this point, block 10 indicates only the sum of the screening crest plus 10 mils (i.e., 26 mils). The additional 7 mils indicated in block 10 on the form is an elevation deviation, which will not become known until after the registration begins.

STEP 3: INITIAL REGISTRATION POINT ALTITUDE	
11. MAP ALTITUDE	$340 + 50 \text{ meters} = 390$
12. RANGE (7) (in thousands)	6.11
13. ELEVATION (10)	26
14. VI (12 $\times$ 13)	159
15. ALTITUDE (RADAR) (Meters)	326
16. ALTITUDE (RP) (14 + 15)	485

- In the blocks for step 3 on the registration form, computes the altitude of the high burst.

- After all members of the radar section have reported READY, reports to FDC (step 4): ALTITUDE (from block 11 or block 16, whichever is greater), AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE.

THE CONTROL UNIT OPERATOR—

- Orients the radar optical axis (telescope) to the pointing azimuth in the following manner:

When the pointing azimuth is announced by the plotter, adds or subtracts the measured field correction to the pointing azimuth. The sum is the AZIMUTH counter reading that must be set on the computer panel in order to orient the telescope (radar optical axis) to the pointing azimuth.

Moves the telescope to the pointing azimuth by placing the DETENT switch in the AZIMUTH ORIENT position and setting the azimuth handwheel in detent. Using the AZIMUTH switch on the control-power supply panel, traverses the antenna until the AZIMUTH counter on the computer panel indicates the value of the chart azimuth with the field correction algebraically added.

Note. If the antenna azimuth counter is operable and the orienting azimuth was inserted during antenna orientation, the telescope is positioned on the pointing azimuth by rotating the antenna until the high-burst chart azimuth appears on the antenna azimuth counter on the radar trailer frame.

CAUTION: Fine adjustments are made with the azimuth handwheel on the radar trailer frame to prevent damage to the azimuth brake.

Prepares the computer and indicator panels by—

Placing the DETENT switch in the OFF position and locking the upper beam controls.

Placing the BEAM VIDEO selector switch in the LOWER position.

Placing the RANGE SHIFT switch in the OFF position.

Placing the RANGE SELECTOR switch in the 3750 M position.

Placing the EXPANDED SWEEP DELAY switch to the appropriate position. The expected range to the burst should be near the center of the 3,750-meter scope.

THE TELESCOPE OBSERVER—

- Assists the control unit operator in orienting the telescope on the pointing azimuth by rotating the azimuth handwheel on the radar trailer frame to make the fine adjustments in azimuth.

- Determines that the announced pointing elevation is at least 10 mils above the screening crest at the pointing azimuth by using the telescope mounted on the radar trailer.

THE RECORDER—

- Enters all known data on the registration form (figure 3-1) and checks the altitude computation performed by the radar plotter. The registration form completed by the recorder can be used to doublecheck the computations of the radar plotter.

- Checks the field correction at the echo box, and announces the amount of the field correction to the control unit operator.

- Insures that the correct reading is set on the elevation counter at the radar trailer when the antenna is set on the pointing elevation.

Checks the level of the radar set.

② Reorientation

The reorientation phase begins when the radar section receives the message SHOT for the first round in the mission. It ends when the deviations of the burst can be read from the telescope and the burst of the projectile appears and is marked on the B-scope (figure 3-3). The duties of personnel during the reorientation phase are outlined below.

THE TELESCOPE OBSERVER—

Takes a position to observe through the telescope.

Looks for the burst through the scope when SPLASH is received.

Immediately spots the deviation in mils from the center of the telescope to the point of the burst when the burst appears.

Note. The observer cannot stand behind the telescope but must stand to the side. Therefore, care must be taken to insure that spotting is correct.

- Reports the deviation in mils to the recorder and insures that the recorder and the radar plotter announce the azimuth and elevation

deviations and record them in the appropriate columns in step 5 on their DA Form 2888.

Note. If the burst is more than 40 mils left or right of the center of the telescope or 10 mils above the center of the telescope, the antenna is repositioned to center the telescope at the point where the first round burst. He uses the azimuth handwheel on the radar trailer to set the new pointing azimuth announced by the recorder.

THE RECORDER—

- Records and announces the azimuth and elevation deviations for each round in the appropriate columns in step 5 on the registration form.

STEP 4: REPORT TO FDC					
ALTITUDE (16 or 11 whichever is the greater)			, AT MY COMMAND, REQUEST SPLASH; READY TO OBSERVE		
485					
STEP 5: RECORDING AND COMPUTATION					
ROUND NO.	FROM B SCOPE		FROM TELESCOPE (HIGH BURST ONLY)		
	RANGE	AZIMUTH	AZIMUTH DEVIATION (Note 3)		ELEVATION DEVIATION
			LEFT (-)	RIGHT (+)	BELOW (-)
1	6300	1675	0	75	0 7

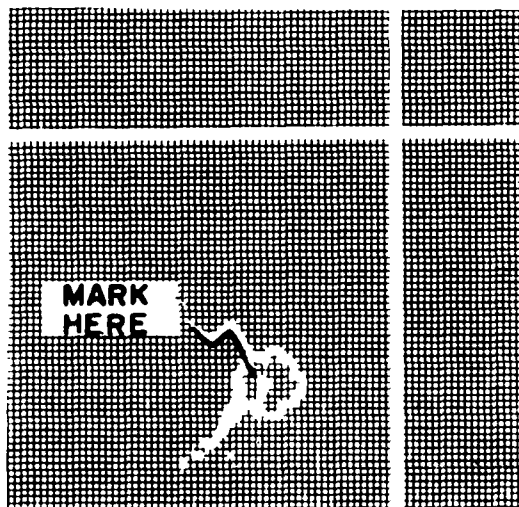


Figure 3-3. Projectile bursting in the beam (HB).

- Calculates the new pointing azimuth and pointing angle of elevation required to cause the round to burst in the beam if the burst from the first round does not appear on the B-scope as shown in figure 3-3. If the burst was to the left of the center of the telescope, he subtracts the amount of the deviation reported by the telescope observer from the pointing azimuth to obtain a new pointing azimuth. If the burst was to the right of the center of the telescope, he adds the amount of the deviation reported by the telescope observer to the pointing azimuth to obtain a new pointing azimuth. If the burst was more than 5 mils below the center of the telescope, he reports to the radar plotter that the next round must be raised in altitude (site).

- Moves to the radar data computer panel when the new pointing azimuth and pointing angle of elevation have been set. He insures that the new pointing azimuth appears on the AZIMUTH counter and that the new pointing elevation appears on the ELEVATION-DEPRESSION counter.

- Enters the new pointing azimuth and elevation on the registration form (step 2, blocks 6 and 10).

STEP 2: INITIAL POINTING DATA	
6. AZ (Nearest 1 mil) (Note 1)	$1639 + 45 = 1679$
7. RANGE (Nearest 10 meters)	6110
8. ELEV TO SC CR	18
9. +10 MIL	+10
10. ELEV (Nearest 1mil) (8 + 9)	$26 + 7 = 33$

- If reorientation was accomplished, the azimuth and elevation deviations to the initial round become zero and the round should be considered usable for computations.

THE RADAR PLOTTER—

- Records in step 5 on the registration form the range and azimuth announced by the control unit operator and the azimuth and elevation deviations reported by the telescope observer.

THE CONTROL UNIT OPERATOR—

- When SPLASH is received, watches the B-scope for the appearance of the echo of the first round.
 - Marks and strobes the burst location.
 - Announces the azimuth and range to the radar plotter.
 - Corrects the elevation of the antenna to the new pointing elevation announced by the recorder if the burst of the projectile does not appear on the B-scope.

During the reorientation phase, the antenna is never lowered. The initial data required setting the elevation at 10 mils above the screening crest. If the antenna is lowered, the beam may be blocked by the screening crest. If the first angle of elevation reported by the recorder is more than 5 mils below the initial pointing elevation, the round will not be used for reorientation or reporting. When the angle of elevation reported is more than 5 mils below the initial point-

ing elevation, the radar plotter notifies the FDC by transmitting BURST TOO LOW, REQUEST SITE (altitude) INCREASE.

In the registration recorded on DA Form 2888 in figure 3-1 the telescope deviations reported by the observer were RIGHT 45, ABOVE 7. The data reported by the control unit operator from the B-scope were RANGE 6300, AZIMUTH 1675. The initial pointing data, recorded in step 2, were changed to reflect these deviations as shown in figure 3-1.

③ Observation

The observation phase begins when the reorientation phase has been completed and ends when END OF MISSION is announced. The duties of personnel during the observation phase are described below.

THE CONTROL UNIT OPERATOR—

- Turns the transmitter on and watches the B-scope for the appearance of the echo as SPLASH is received for each round.
 - Marks the echo.
 - Turns the transmitter off.
 - Strobes the echo.
 - Announces the range and azimuth to the radar plotter.
 - Reports LOST if the round is not observed. If the round does not burst in the beam of the radar, it cannot be used in registration.

THE TELESCOPE OBSERVER—

- Takes a position to observe through the telescope when SHOT is received.

WARNING: The observer must not stand erect in the radar beam. He should kneel down (away from the beam) and not raise his head above the level of the telescope because of the radiation hazard.

- Looks for the burst through the telescope when SPLASH is received.
- Announces the azimuth deviation as LEFT or RIGHT (so much) and the elevation deviation as ABOVE or BELOW (so much) when the burst appears.
- Announces LOST if he does not observe the round.

THE RECORDER—

- Records on the registration form the azimuth and elevation deviation announced by the telescope observer and insures that the information is received by the radar plotter.

- Records the range and azimuth announced by the control unit operator.

THE PLOTTER—

- Records the azimuth and elevation deviations announced by the recorder.

- Compares the azimuth announced by the recorder to the azimuth announced by the control unit operator. The two azimuths must agree within ± 10 mils. If they do not agree, he checks to determine if an error has been made. If necessary, he requires an additional round to be fired. The radar officer or the chief of section will determine when the data have been recorded for six usable rounds.

When the data have been recorded for six usable rounds, END OF MISSION is transmitted to the fire direction center.

④ Computation

The computation phase begins when the possibility of erratic rounds has been eliminated. During this phase, both the plotter and recorder perform the computation required. Each member works independently of the other. Results are compared when the totals are determined; when the final range, azimuth, and elevation are determined; when the altitude is computed; and immediately before the report is sent to the fire direction center. The high-burst location is computed on the DA Form 2888 as follows:

Note. Rounds 5 and 7 were deleted as erratic because they differed significantly in azimuth or range from other rounds.

3	6250	1672
4	6340	1680
5	6320	1677
6	6290	1675
7	6000	1650

8	6220	1680
TOTAL	17. 37680	18.

The ranges from the RANGE counter on the computer panel are added, and the total is recorded in block 17 (figure 3-1).

The azimuth and elevation deviations are totaled (blocks 19 and 20).

19. AZIMUTH DEVIATION = ALGEBRAIC
TOTAL LEFT (-) AND RIGHT (+)

+16

20. ELEVATION DEVIATION = ALGEBRAIC
TOTAL BELOW (-) AND ABOVE (+)

-18

The totals obtained by the plotter are compared with those obtained by the recorder. If the totals do not agree, the error must be found before the computation is continued.

In a high-burst registration, the azimuths from the AZIMUTH counter on the computer panel are not totaled. These azimuths are used only during the observation phase for comparison with the azimuth computed from the telescope observer's deviations.

The totals are divided by the number of usable rounds to determine the average range (block 23), the average azimuth deviation (block 21), and the average elevation deviation (block 22).

The average range is the range to the high burst (block 31).

The average azimuth deviation is algebraically added to the initial pointing azimuth (block 6), using blocks 25 and 26. The result is the high-burst azimuth (block 29).

The average range and azimuth are plotted on the radar chart and also are placed in the radar set computer. If the coordinates obtained do not agree within 20 meters, they must be recomputed and replotted.

23 REGISTRATION POINT RANGE (Nearest 10 meters) 6280 6 37680 (17) 6280	24. AZIMUTH OF MPI (Nearest 1 mil) 6 NOT USED (18)	21 0 2.6 6 +16 (19)	22. +3 6 -18 (20)
STEP 6. FINAL REGISTRATION POINT ALTITUDE		STEP 7. REPORT TO FDC	
31. RP RG (23) (In thousands) 6.280	36. REPORT ON RADAR OBSERVED (Check applicable box) ☒ HB ☐ MPI		
32. HB (Enter value black (30)) MPI (Enter value black (10)) 30	37. TIME OBSERVED 261500		
33. VI (31 × 32) 188	38. AZIMUTH (MPI (24) HB (29)) (See note 4) 1682		
34. ALTITUDE RADAR 326	39. RANGE (23) (See note 4) 6280		
35. ALTITUDE RP (33 + 34) 514	40. ALTITUDE (35) (See note 4) 514		
		41. GRID OF RP (Nearest 10 meters) 6414 3866	

DA FORM 2888
1 MAY 75

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

The average elevation deviation is algebraically added to the initial pointing elevation (block 10), using blocks 27 and 28. The result is the high-burst elevation (block 30).

The high-burst range, azimuth, and elevation obtained by the plotter are compared with those obtained by the recorder. If the values do not agree, the work is recomputed until the error is corrected.

The high-burst altitude is computed by multiplying the high-burst elevation (block 32) by the high-burst range (block 31) in thousands and adding the product to the altitude of the radar as shown in step 6 on the registration form.

The high-burst altitude (block 35) computed by the plotter is checked with that computed by the recorder. If the values do not agree, the work is recomputed until the error is found.

⑤ Reporting to FDC (Step 7, DA Form 2888)

When the computations made by the plotter and those made by the recorder have been compared and are found to agree, the location of the high burst is transmitted to the FDC as grid or polar plot coordinates. This report consists of

the following six elements, transmitted in the order in which they are listed:

- REPORT ON RADAR-OBSERVED HIGH BURST—Informs the FDC of the type of message to follow.
- TIME OBSERVED—Provides the FDC and the radar section with a message number for future reference to the registration. It is the approximate time at which the firing was completed.
- DIRECTION (azimuth)—The azimuth from the radar antenna to the high-burst location.
- DISTANCE (range)—Range from the radar antenna to the high-burst location.
- ALTITUDE—The computed altitude of the high-burst location.
- GRID—The grid coordinates of the high-burst location.

Note. When grid coordinates are reported, the direction and distance may be omitted. Direction and distance will be given only when coding is used.

Both computers record the report to the FDC in step 7 on the registration form. The radar plotter transmits the message to the fire direction center. The recorder listens as it is transmitted to insure that no errors are made.

STEP 7 REPORT TO FDC	
36 REPORT ON RADAR OBSERVED (Check applicable box)	
☒ HB	☐ MPI
37 TIME OBSERVED	261500
38 AZIMUTH (MPI (24) HB (29)) (See note 4)	1682
39 RANGE (23) (See note 4)	6280
40 ALTITUDE (35) (See note 4)	514
41 GRID OF RP (Nearest 10 meters)	6414 3866

3-9. Radar-Observed Mean-Point-Of-Impact Registration

A mean-point-of-impact registration is fired with point-detonating fuzes. However, the projectiles may not be observed at impact, since the radar normally will be sited behind a mask. The registration will be observed at a selected datum plane (SDP). A datum plane is a horizontal plane in space through which all rounds pass that are fired during the conduct of the MPI registration. It may be described as an imaginary hilltop or a mound of dirt on which the rounds actually impact. The selected datum plane is the plane where all rounds in the registration pass through the center of the lower beam. The use of the optical telescope is not required. All information is determined by strobing the point where each round passed through the center of the lower beam.

The radar section is alerted to observe a mean-point-of-impact registration by a message to observer. The message to observer for a mean-point-of-impact registration is the same as that for a high-burst registration.

The procedures for determining the Initial Pointing Data (step 2, DA Form 2888) are the same as those for a high-burst registration.

Under step 3 on the registration form, the

STEP 2: INITIAL POINTING DATA	
6. AZ (Nearest 1 mil) (Note 1)	1639 + 45 = 1679
7. RANGE (Nearest 10 meters)	6110
8. ELEV TO SCR	18
9. +10 MIL	+10
10. ELEV (Nearest 1mil) (8 + 9)	26 + 7 = 33

SEE NOTES ON REVERSE	
STEP 3: INITIAL REGISTRATION POINT ALTITUDE	
11. MAP ALTITUDE	340 + 50 meters = 390
12. RANGE (7) (in thousands)	6.11
13. ELEVATION (10)	26
14. VI (12 x 13)	159
15. ALTITUDE (RADAR) (Meters)	326
16. ALTITUDE (RP) (14 + 15)	485

altitude of the selected datum plane (SDP) is computed.

When performing mean-point-of-impact registrations, the radar antenna need not be reoriented, since the radar beam is wide enough to cover the registration point.

Performance of a mean-point-of-impact registration requires six usable rounds.

Note. MPI registration can be accomplished using three rounds (determined by FDO). Range and azimuth to each round are determined by strobing the center of the target echo on the B-scope.

The results of a mean-point-of-impact registration are sent to the fire direction center.

3-10. Marking and Strobing Target Echoes for Mean-Point-Of-Impact Registration

The accuracy of the mean-point-of-impact registration depends to a great degree on the

procedure used in marking and strobing the echo on the B-scope. In the mean-point-of-impact registration, the azimuth and range are obtained from the computer.

The appearance of the echo for a mean-point-of-impact registration is similar to that for a high-burst registration except that the round does not burst in the beam. The operator sees only a trace of light as the round passes through

the lower beam. He marks the point of entry, follows the round until it disappears, and marks the point of exit. After marking the entry and exit points, the operator must interpolate and mark a point halfway between the entry and exit points. This center point is strobed for azimuth and range. The procedure is illustrated in figures 3-5 through 3-8.

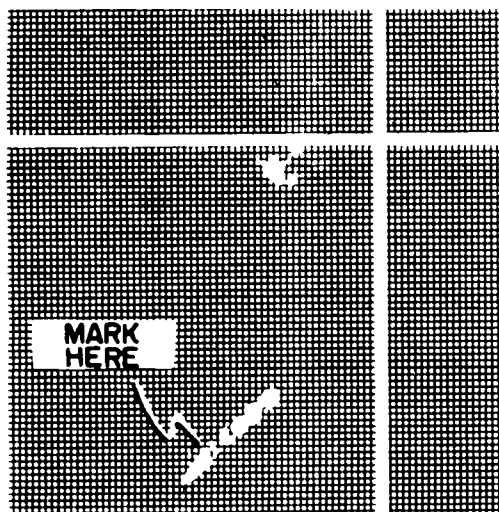


Figure 3-5. Marking the point where the projectile enters the beam (MPI).

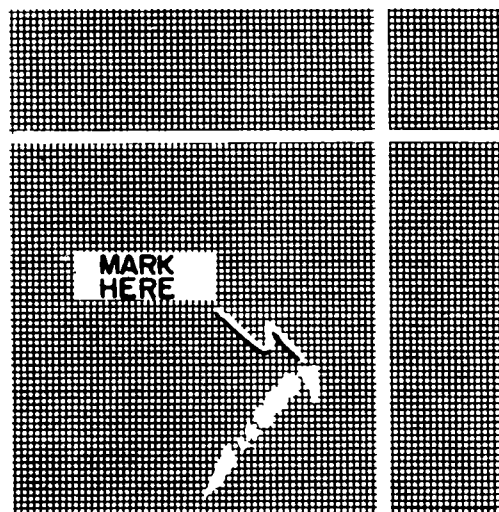


Figure 3-6. Marking the point where the projectile leaves the beam (MPI).

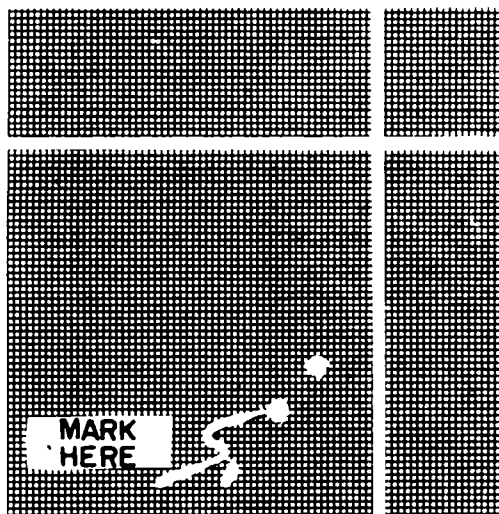


Figure 3-7. Marking the point where the projectile passed through the center of the beam (MPI).

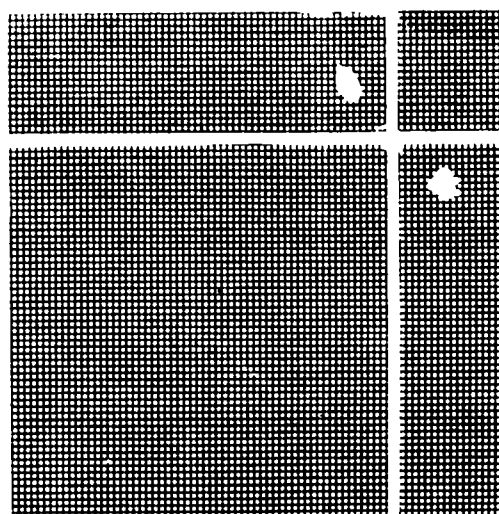


Figure 3-8. Strobing the midpoint.

3-11. Conduct of Mean-Point-Of-Impact Registration

Preliminary checks and adjustments of the radar must be performed as they are for a high-burst registration.

Three members of the radar section are needed to conduct a mean-point-of-impact registration. They are the—

CONTROL UNIT OPERATOR.

RADAR PLOTTER.

RECORDER.

When the radar section receives the message to observer, the procedures to be followed and the duties of the crewmembers are similar to those for a high-burst registration. Since the mean-point-of-impact registration is fired with a point-detonating fuze, the rounds cannot be observed through the telescope; therefore, the observer cannot report the deviations of the rounds. The range and azimuth to each round are determined from the B-scope. When six usable rounds have been detected, their ranges and azimuths are averaged to find the range and azimuth to the mean point of impact. The angle of elevation at which the rounds are observed is the pointing elevation. The duties of the crewmembers for a mean-point-of-impact registration are similar to those for a high-burst registration. Since the telescope is not used in a mean-point-of-impact registration, there is no reorientation phase. The data recorded throughout all phases of the registration are illustrated on the completed DA Form 2888 in figure 3-9. The phases of the registration are as follows:

① PREPARATION.

② OBSERVATION.

③ COMPUTATION.

④ REPORTING.

① Preparation

The preparation phase begins when the radar section receives the message to observer and ends when the radar section reports READY TO OBSERVE. The duties of the crewmembers during the preparation phase are as follows:

THE RADAR PLOTTER—

- Records the message to observer on the DA Form 2888 as shown in figure 3-9.
- Plots on the radar chart the coordinates given in the message to observer.
- Measures the azimuth and range to the announced mean point of impact and announces aloud the following data: AZIMUTH 0624 (always read to the nearest mil), RANGE 5410 (always read to the nearest 10 meters).
- Records the announced azimuth and range as the pointing azimuth and range in step 2, blocks 6 and 7, on DA Form 2888.
- Records in block 8 the angle of elevation to the screening crest announced by the recorder, totals blocks 8 and 9, and records the sum to the nearest mil in block 10 as the pointing elevation.
- Uses the range (in thousands) and the pointing elevation to compute the altitude of the selected datum plane (step 3, DA Form 2888).
- After all members of the radar section have reported READY, reports to the FDC (step 4) ALTITUDE (from block 16), AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE.

THE CONTROL UNIT OPERATOR—

- Traverses the radar antenna to the vicinity of the pointing azimuth. To move the antenna to the approximate pointing azimuth, he positions the azimuth strobe in the center of the B-scope and rotates the antenna until the AZIMUTH counter on the computer panel indicates the approximate pointing azimuth.
- When directed by the recorder, moves the antenna to the pointing elevation, using the ELEVATION switch on the control-power supply panel.
- Prepares the computer and indicator panels by—

*Placing the DETENT switch in the OFF position, and locking the upper beam controls.
Placing the BEAM VIDEO selector*

RADAR OBSERVED HIGH-BURST OR MEAN POINT-OF-IMPACT (DATUM PLANE) REGISTRATION For use of this form, see FM 6-161 the proponent agency is TRADOC.				SEE NOTES ON REVERSE			
STEP 1 MESSAGE TO OBSERVER		STEP 2 INITIAL POINTING DATA		STEP 3 INITIAL REGISTRATION POINT ALTITUDE			
1 OBSERVE (Check applicable box) ☐ HB ☒ MPI		6 AZ (Nearest 1 mil) (Note 1) 624		11. MAP ALTITUDE +SD meters= 366 416			
2 FOR (Unit or call sign) 241342		7 RANGE (Nearest 10 meters) 5410		12 RANGE (7) (in thousands) 5.410			
3 AT GRID 5230 4860		8 ELEV TO SC CR +22		13 ELEVATION (10) +32			
4 REPORT ALTITUDE		9 +10 MIL +10		14. VI (12 x 13) 173			
5 REPORT WHEN READY TO OBSERVE		10 ELEV (Nearest 1 mil) (8 + 9) +32		15 ALTITUDE (RADAR) (Meters) 370			
				16 ALTITUDE (RP) (14 + 15) 543			
STEP 4 REPORT TO FDC							
ALTITUDE (16 or 15 whichever is the greater) 543, AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE							
STEP 5 RECORDING AND COMPUTATION							
ROUND NO.	FROM B SCOPE		FROM TELESCOPE (HIGH BURST ONLY)				
	RANGE	AZIMUTH	AZIMUTH DEVIATION (Note 3)		ELEVATION DEVIATION		
			LEFT (-)	RIGHT (+)	BELOW (-)	ABOVE (+)	
1	5390	619					
2	5380	617					
3	5420	621					
4	5400	618					
5	5410	620					
6	5390	624					
TOTAL	17	18	TOTAL LEFT (-)	TOTAL RIGHT (+)	TOTAL BELOW (-)	TOTAL ABOVE (+)	
NOTE AFTER SIX VALID ROUNDS REPORT END OF MISSION TO FDC			19 AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (-) AND RIGHT (+)		20 ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (-) AND ABOVE (+)		
23 REGISTRATION POINT RANGE (Nearest 10 meters) 5398 6 32390 (17)		24 AZIMUTH OF MPI (Nearest 1 mil) 619.8 = 620 6 3719 (18)		21 + 6 6 19 (19) 25 (21) NOT USED 26 (6) NOT USED 29 HB AZ (Algebraically add 25 and 26)		22 + 6 6 19 (20) 27 (22) NOT USED 28 (10) 30 HB ELEV (Algebraically add 27 and 28)	
STEP 6 FINAL REGISTRATION POINT ALTITUDE				STEP 7 REPORT TO FDC			
31 RP RG (23) (In thousands) 5.39				36 REPORT ON RADAR OBSERVED (Check applicable box) ☐ HB ☒ MPI			
32 HB (Enter value block (30)) MPI (Enter value block (10)) +32				37 TIME OBSERVED 261825			
33 VI (31 + 12) 172				38 AZIMUTH (MPI (24) HB (29)) (See note 4) 620			
34 ALTITUDE RADAR 370				39 RANGE (23) (See note 4) 5398			
35 ALTITUDE RP (33 + 34) 542				40 ALTITUDE (35) (See note 4) 542			
				41 GRID OF RP (Nearest 10 meters) 5234 4880			

DA FORM 2888

1 MAY 75

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

Figure 3-9. DA Form 2888 showing a completed MPI registration.

switch in the LOWER position.

Placing the RANGE SHIFT in the OFF position.

Note. When performing the following, the transmitter will be fired only for short durations and not to exceed 10 seconds per burst.

- During a night registration, when no screening crest profile has been prepared, or when the screening crest cannot be observed through the telescope, orients the antenna in elevation by—

Elevating the antenna until the B-scope is free of all clutter.

Depressing the antenna until clutter starts to appear but not so low that it appears in the area where the mean-point-of-impact registration will be conducted.

Entering in block 10 on the registration form the elevation indicated on the ELEVATION-DEPRESSION counter on the radar trailer.

THE RECORDER—

Enters all known data on DA Form 2888 and checks the computations performed by the radar plotter. The DA Form 2888 completed by the recorder can be used to doublecheck the computations of the radar plotter.

Directs the control unit operator to elevate the antenna until the center of the telescope is approximately 10 mils above the screening crest. When the antenna is oriented in elevation, he reads the elevation indicated on the elevation counter at the radar trailer. He then applies any elevation corrections determined during the elevation orientation check, reports the corrected elevation to the radar plotter, and enters the value on DA Form 2888.

② Observation

The observation phase begins when the radar section reports READY TO OBSERVE and ends when the data from six usable rounds

have been recorded. The duties of personnel during the observation phase are as follows:

THE CONTROL UNIT OPERATOR—

- Watches the B-scope for the appearance of the echo as SPLASH is received for each round.
- Marks the point of entry, where the round enters the beam.
- Marks the point of exit, where the round leaves the beam (the echo disappears).
- Interpolates and marks the point where the round passed through the center of the beam.
- Strokes the center point and announces the range and azimuth, as indicated on the RANGE and AZIMUTH counters on the computer panel, to the radar plotter and the recorder.
- If the round is not observed, reports LOST.

BOTH THE RADAR PLOTTER AND THE RECORDER WILL RECORD IN STEP 5 ON DA FORM 2888 THE RANGE AND AZIMUTH ANNOUNCED BY THE CONTROL UNIT OPERATOR.

Note. Average the six rounds. If any round is out by more than 50 meters in range and 10 mils in azimuth from the average, a call for a repeat of that round is required.

③ Computation

In the computation phase, the duties of both the recorder and the radar plotter are the same as those for the high-burst registration except that the azimuth read from the AZIMUTH counter on the computer panel is used in determining the azimuth to the mean point of impact and the angle of elevation used in computing the altitude of the mean point of impact is the pointing elevation.

④ Reporting to FDC

The reporting phase in the mean-point-of-impact registration is the same as that in the high-burst registration.

Section III. RADAR ADJUSTMENT OF FIRE

3-12. General

The decision to fire or not to fire artillery and the choice of the method of attack on any target are made by the S3 of the firing unit. If the initial target location is accurate, first-round fire for effect may be delivered on the target. However, if the initial target location is doubtful, an observer must be used to adjust the fire on the target. Radar may be used as the observer during the adjustment phase of a fire mission. Normally, radar will be used only when no visual observation means is available and when one or more of the following conditions exist:

NO REGISTRATION CORRECTIONS ARE AVAILABLE.

NO SURVEY EXISTS.

THE TARGET HAS BEEN LOCATED BY RADAR.

If the fire direction officer (FDO) decides to adjust on a target, using radar as the observer, the radar crew must be able to perform the adjustment rapidly and accurately. Speed, consistent with accuracy, is essential. The more time required for the adjustment, the more time the enemy will have to dig in or run.

3-13. Fire Adjustment Principles Pertinent to Radar

The goal of an adjustment is to move the burst of one round to the center of the target or target area. It is not necessary for the radar crew to know the location of the firing unit or the fire direction center, nor is it necessary for the fire direction center to know the location of the radar. The adjustment is begun by firing one round into

the area of the target. When the location of the burst of the adjusting round is determined, the radar crew computes the correction necessary to move the burst to the target center. The *first* principle of radar fire adjustment is to move the burst to the target center. The *second* principle of fire adjustment is speed. Speed in adjustment is improved by training and by the use of standard terms and procedures. The standard call for fire, the subsequent corrections, and the adjustment techniques must be correctly understood and used by the radar crew.

3-14. Target Location Information

To increase the accuracy of the radar in acquiring the first round fired, the target location information furnished by the S3 to the radar section must be as accurate as possible. The methods of describing the target location and their order of preference are as follows:

Grid Coordinates

These provide the most accurate data, and since they are based on a common grid system, there is no problem in understanding the exact target location.

Shift from a Known Point

This method can be used when no survey control exists and the firing unit and the radar are not on a common grid but do have common known points on their charts. This method allows the FDC to locate the target in relation to one of these known points.

Mark Center of Sector

When the firing unit and the radar have no common known points on their charts and no survey control exists in the area, this method is

used to place a known point on both charts. The firing unit fires a round into an area that they can visually observe; at the same time, the radar section locates this round with the radar. This location now serves as a common known point on both charts.

3-15. Call For Fire

When radar is used to adjust fire, the radar section must determine and transmit the call for fire and the subsequent correction to the fire direction center. The call for fire is transmitted in a standard message format, using standard terminology, and contains the information required by the FDC for the preparation of fire commands. The information is transmitted in the order in which it will be used in the fire direction center. Subsequent corrections are transmitted to obtain changes in the elements of the call for fire necessary to move the bursts to the target center.

The call for fire contains seven elements. These elements are listed below in the order in which they are used. For a detailed explanation of each element, see FM 6-30, chapter 4.

OBSERVER IDENTIFICATION.

WARNING ORDER.

LOCATION OF TARGET.

DESCRIPTION OF TARGET.

METHOD OF ENGAGEMENT.

METHOD OF FIRE AND CONTROL.

DIRECTION 6400.

The characteristics of the AN/MPQ-4A radar require that some elements of the call for fire include information normally not included by a ground observer. Specifically, since the AN/MPQ-4A can more accurately locate the point of origin or the burst of a single projectile fired at a high angle of elevation, the call for fire will include the terms ONE GUN and HIGH ANGLE in the method of engagement element. When the radar section wishes to control the time of firing, AT MY COMMAND is included in the method of fire and control element.

3-16. Message to Observer

After the call for fire has been received, the fire direction officer issues a fire order. This fire order consists of the necessary commands for the FDC to start the production of firing data. Certain elements of the fire order are extracted by a computer in the FDC and are sent to the radar section as a message to observer. This message to observer always contains four elements and any modification to the radar section's call for fire. The elements are as follows:

BATTERIES TO FIRE FOR EFFECT. The first element informs the radar section which batteries will fire for effect.

ADJUSTING BATTERY. The second element informs the radar section which battery will conduct the adjustment.

ROUNDS IN FIRE FOR EFFECT. The third element informs the radar section of the number of rounds that will be fired by each tube during fire for effect.

TARGET NUMBER. The fourth element is the designation assigned to the target.

MODIFICATION. A modification is any change to any element in the radar section's call for fire. As an example, the standard call for fire implied shell high explosive and fuze quick. However, the S3 decided that shell white phosphorus, fuze quick, would be used. The message to observer sent to the radar section is:

FDC: BATTALION, BRAVO, WP, 1
ROUND, TARGET 126, OVER.

3-17. Radar Considerations

For adjustments, as for any other mission the radar may be assigned, the site should be selected so that the angle of elevation to the screening crest is at least 15 mils but not more than 40 mils. The radar should be emplaced, leveled, collimated, and oriented by the best

means available. Range calibration and the accuracy of the computer should be verified.

A radar chart may be used in conducting a radar adjustment. If the radar location cannot be determined by survey or by map inspection, a grid intersection is selected as the radar position and is assigned arbitrary coordinates and altitude. The shift necessary to move the burst to the target may be computed or may be determined from the target grid. See FM 6-40 for a discussion of the target grid.

3-18. Subsequent Corrections

After the first burst has been located by the radar, the radar section transmits subsequent corrections until the fire mission is completed. The corrections include appropriate changes to elements previously transmitted and the necessary corrections for deviation and range. A subsequent correction includes either a correction for deviation or range (or both) or the term REPEAT, in which case no subsequent corrections are made. The term REPEAT also is used to indicate that the observer desires to repeat fire for effect with or without correction to any of the elements (e.g., ADD 50, REPEAT). Any other element of the call for fire for which a change or correction is not desired is omitted in the subsequent correction.

When the radar crew desires to change the method of control from adjust fire to fire for effect, FIRE FOR EFFECT is sent as part of the subsequent correction.

3-19. Procedure for Adjusting Fire

When the radar section is prepared to start the adjustment mission, the call for fire is sent to the fire direction center. The radar plotter plots the target location on the radar chart. If the radar and firing units are not on a common survey grid, the radar chart is set up with the

radar plotted at map inspection coordinates or, if no map is available, at a grid intersection with assumed coordinates and altitude.

In the grid coordinate comparison method, the adjustment is performed by sending a direction of 6,400 mils to the fire direction center. The antenna is moved in azimuth and elevation (screening crest plus 10 mils along the radar target line) until it is pointing at the target. The radar plotter sends a request for 1 ROUND, HIGH ANGLE, AT MY COMMAND to the fire direction center.

When the battery is ready to fire the round, the message BATTERY READY is transmitted to the radar section. When the radar section is ready for the first round to be fired, the command FIRE is sent to the guns. If the first round is not located by the radar, the radar section must quickly check to verify that no error has been made in orientation or computation. When the radar section is again ready to observe, the plotter transmits the command UNOBSERVED, REPEAT to the fire direction center. The command UNOBSERVED, REPEAT informs the fire direction center that the radar section did not obtain data for corrections and desires that another round be fired at the same location.

When the location of the burst has been determined, it is compared to the target location grid coordinates. The difference in easting (dE) is the lateral shift and the difference in northing (dN) is the range shift.

EXAMPLE:

Grid coordinates of target	27300	33700
Grid coordinates of burst	27100	33500
	RIGHT 200	ADD 200

This shift, to move the burst to the target, is sent to the fire direction center: RIGHT 200, ADD 200. These corrections are announced to the nearest 10 meters. The shift (or correction) RIGHT or LEFT (so much), ADD or DROP (so much) is understood to be in meters, even though the word "meters" is not expressed.

The adjustment is continued until a round bursts within 100 meters of the target in devia-

tion and range. The radar section then sends final corrections and requests fire for effect; for

example, RIGHT 50, ADD 90, FIRE FOR EFFECT.

Section IV. RADAR SURVEY

3-20. General

The possibility of conflict in remote areas of the world places an increased requirement on the artillery to be able to conduct fire on a target with data obtained from inaccurate maps or even without maps. The artillery must be able to deliver rapid and accurate fire in remote areas, often without survey control or adequate time to complete an observed firing chart. The AN/MPQ-4A radar can be used to provide hasty survey control between the radar position and the artillery firing units by combining the procedures for marking a weapon location with those for observing a high-burst registration.

3-21. Conduct of a Radar Survey

Emplacement of the Radar

To conduct a survey mission, the radar should not be closer than 1,000 meters to the weapons that are to be surveyed. (If a weapon is closer than 1,000 meters to the radar, a short survey traverse provides more reliable data.) The radar site should meet the normal positioning requirements for weapon location and radar gunnery applications. Assumed coordinates and altitudes are set into the radar set computer.

Battery Coordinates

The coordinates of each battery center, relative to the radar, are determined by the radar section, using standard weapon location techniques. The radar beam is positioned over the battery being located. The base piece fires

one round at high angle, and the location of the base piece is determined from data based on this one round.

Battery Altitude and Common Direction

The center battery fires a high-burst registration that can be observed from the radar set and from the battery center of each battery being provided survey. Each battery executive officer observes the high burst with an aiming circle set up over the battery center and laid parallel to the guns. The battery executive officers of the flank batteries measure and record the deflection and the vertical angle to the high burst. Each executive officer computes the mean deflection and vertical angle to the high burst. The registration deflection effect is the difference between the registering executive officer's orienting deflection and his recorded mean deflection to the high burst. The correction is opposite the effect. The radar section provides the coordinates and altitude of the high burst, both of which are relative to the assumed altitude and coordinates set into the radar computer. The location of the high burst is plotted on the firing chart. The deflection indexes for the flank batteries are constructed at a value equal to the deflection correction modified by an error which occurred when the battery was initially laid. This error is determined by comparing the measured azimuth from each flank battery with the azimuth between the radar-provided battery location and the high-burst location. The center battery deflection index is constructed at the adjusted deflection to the high burst. The vertical angle measured from each battery is converted to a vertical interval, using the radar chart range, and is applied to the high-burst altitude. This procedure provides the altitude of each battery that observed the high burst.

Section V. TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

3-22. Tactical Missions

Some considerations affecting the mission assigned to the AN/MPQ-4A radar section are:

Mission of the supported force.

Tactics and employment techniques of the enemy artillery.

The amount and type of weapons in the enemy force and the degree to which they are active.

The capabilities and limitations of the AN/MPQ-4A radar and other available target acquisition systems.

After considering the above factors, the commander will assign one or more of the following missions and assign sector(s) of search:

Location of enemy mortars.

Location of enemy artillery.

Radar gunnery.

Since the radar section cannot perform the first two missions above concurrently, the normal practice is to assign a primary mission of locating either hostile mortars or hostile artillery and a secondary mission of radar gunnery.

3-23. Selection of Site

Coordination of search areas for all radars is essential to insure complete coverage of the target area. Within the division, this coordination is performed by the division artillery assistant S3 for plans. The radar visibility diagram (para 3-26), which is provided to the division artillery S3, enhances the coordination of all target acquisition activities.

After the tactical mission is assigned to the artillery battalion, the battalion commander (S2) designates a general position area within which the radar section may select a position. If the section is not attached to a battalion, the battery commander of the target acquisition battery (TAB) or the radar platoon leader will designate the general position area. This general position area should encompass an area large enough that the field artillery radar technician or section chief may select the actual radar site on the basis of the technical and tactical considerations affecting the operation of the radar.

If possible, the radar position should be adjacent to the center battery of a firing battalion to simplify communications, to facilitate survey and logistics, and to enable the section to take advantage of any existing defensive perimeter. Depending upon the mission, terrain, and tactical situation, the radar position area should be located from 2,000 to 4,000 meters behind the FEBA in the offense and from 3,000 to 7,000 meters behind the FEBA in the defense to provide maximum flexibility of operation.

After the general position area has been designated, the radar technician or chief of section will make a reconnaissance before selecting the actual radar site. If time permits, this reconnaissance will be divided into two phases, a map reconnaissance and a ground reconnaissance.

The map reconnaissance is made to determine, but is not limited to, the following:

- Possible sites available.
- Routes into and out of the area.
- Identifying landmarks.
- Locations of adjacent units.

A ground reconnaissance is made after the map reconnaissance to aid in occupation of the selected position. The ground reconnaissance is

based on the tactical and technical considerations for the radar as modified by the particular mission, situation, and terrain. Since the time available for reconnaissance is generally limited, the reconnaissance must be organized so that it can be accomplished as completely as possible in the time allotted. It must be detailed enough to allow the radar technician or chief of section to make decisions and issue orders concerning:

- The exact location of the radar.
- The location of the radar operations center.
- The location of the generator.
- The location of the truck park.
- Routes into and out of the area.
- Searching and marking the area for mines.
- Local security, to include camouflage and defense against air and ground attack.
- The selection of alternate positions.

3-24. Tactical Considerations

The tactical considerations in selecting a radar site are similar to those in choosing a position for a field artillery firing battery. Normally, these considerations include communications, concealment, cover, routes of approach, security, and survey.

Communication

The communication requirements vary with the mission assigned to the radar section, but the site must permit the required communications to be established. Wire and/or radio are the normal means of communication for the radar section.

Concealment

In selecting a site for the radar, advantage must be taken of natural concealment, such as trees and shrubs.

Cover

The radar should be emplaced in defilade to the enemy to give personnel and equipment all possible protection from hostile fire.

Routes of Approach

The site selected for the radar should have more than one route of approach that will allow occupation of the site without being observed by the enemy. Road conditions, overhead clearances, bridges, and stream fords must be considered.

Physical Security

If possible, the radar site should be selected within the defensive perimeter of another unit to ease the local security requirements for the radar section.

Electronic Security (ELSEC)

This pertains to protective measures applied to intentional electromagnetic radiations of noncommunications equipment and systems to prevent the interception, analysis, or exploitation of those radiations by foreign intelligence collection efforts. One of the most important protective measures for radar is the screening crest. ELSEC is an important aspect of OPSEC and tactical cover and deception. FM 32-6, *SIGSEC Techniques*, covers the functions and techniques of ELSEC in detail.

Operational Security (OPSEC)

This includes all actions necessary and appropriate to deny the enemy information concerning planned, ongoing, or completed operations.

Survey

The selection of a site near a firing battery or a known survey point aids in the determination of the coordinates and altitude of the radar and the azimuth and elevation to a known point for orientation purposes.

When time and the tactical situation permit, survey data will be provided by the TAB, div arty, or the supported unit. However, during the rapid movement of units on the battlefield, survey parties will be hard pressed to provide all radar sections survey data. Therefore, radar sections may at times have to provide their own survey control.

The three elements of survey control are direction, location, and altitude. The techniques

used to determine these three elements are called hasty survey techniques and are found in FM 6-50, *Field Artillery Cannon Battery*, chapter 9.

3-25. Technical Considerations

Echoes are frequently received from objects outside the main lobe of the radar beam. These echoes can cause clutter to appear on the radar scope and obscure actual target returns. Ideally, the radar is positioned in shallow defilade so that the objects that cause the clutter are masked by a hill or ridge. This mask is called a screening crest. The clutter (caused by the mask itself) appears at close range, where it will not interfere with the detection of desired targets. Equally important, the screening crest provides essential electronic security protection. The crest should be in friendly territory and within 1,000 meters of the radar, since the area between the radar and the screening crest will be obscured by clutter and therefore cannot be used for detection of weapons. It is desirable that the radar scan at an elevation of 50 mils or less; therefore, the elevation to the screening crest should be at least 15 mils but not more than 40 mils. A screening crest is essential as a defense against electronic countermeasures.

Other technical considerations that should be considered in selecting the radar site are:

- Maximum range of the radar (15,000 meters).

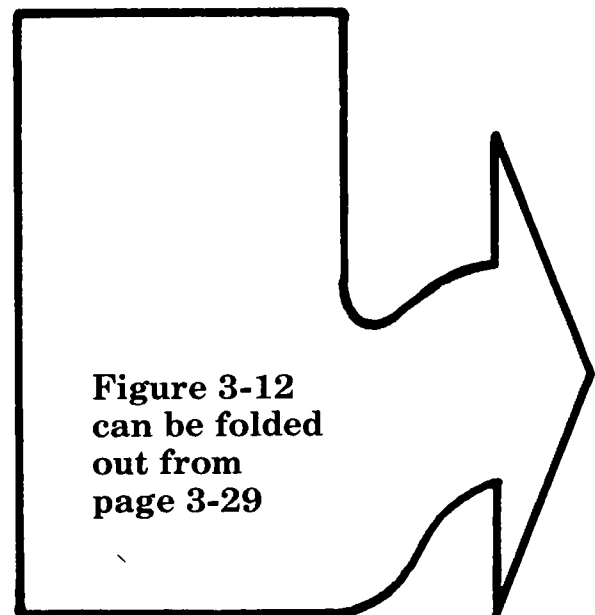
- Sector coverage (445 mils).

3-26. Site Evaluation

Since most sites selected represent a compromise between what is desired and what is available, it is likely that there will be blind spots of significant size in the radar's assigned area of responsibility. It is necessary that the battalion S2 and the div arty TOC have a diagram showing the sectors being searched and the significant

blind spots within these areas. With this information, the S2 can prepare the radar portion of the target acquisition capabilities chart and can provide other means of coverage for the blind spots, if available and desirable.

The radar visibility diagram (figure 3-12) is an overlay showing the boundaries (azimuth and range) of the sectors (normally not to exceed three) actually being searched and all areas within these sectors that cannot be observed. Sectors of search are overlapped so that sector centers are 400 mils apart. Sectors adjacent to those actually being searched also may be included when time permits or if required by unit SOP. One copy of the diagram is retained by the radar section for use by the radar operator; the number of copies forwarded to higher headquarters for further distribution will be established by the unit SOP. (Construction of the diagram is discussed below.)



Note. Construction of the clutter portion of the radar visibility diagram (figure 3-12) involves possible compromise of electronic security and will only be accomplished at the direction of the commander.

SCREENING CREST PROFILE.

The radar section also prepares a screening crest profile (figure 3-10) for use by the radar operator in choosing a scanning elevation or the elevation to be used for radar-observed registrations. Elevations for the profile may be determined with an aiming circle during the ground reconnaissance or with the orienting telescope of the radar set after occupation of the site. In either case, the instrument is set at zero elevation and the elevation to the screening crest is read directly from the reticle. Screening crest elevations normally are measured every 100 mils throughout the sectors being searched. If the screening crest is very irregular, the interval between readings must be reduced. The elevation readings are plotted at the azimuth at which they were determined, as shown in figure 3-10.

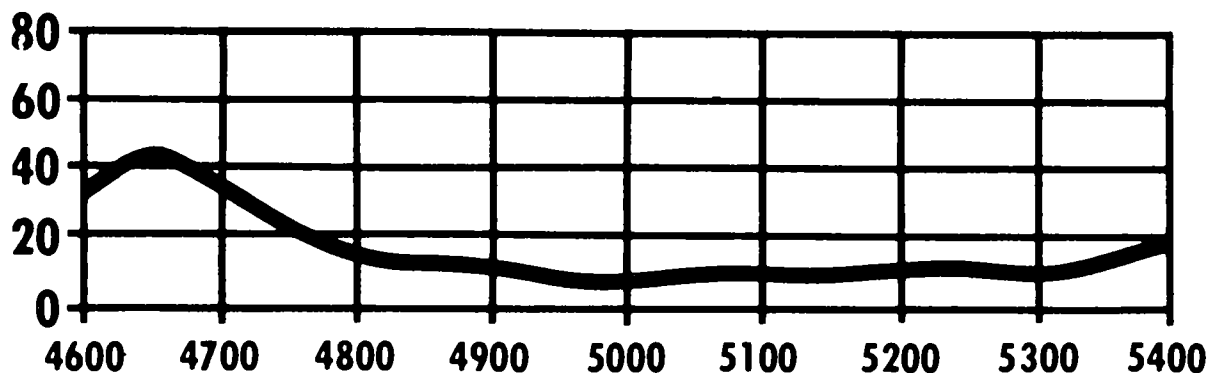


Figure 3-10. Typical screening crest profile.

While measuring screening crest elevations, the section should measure the elevations of hill masses that can be seen above the screening crest and then construct a skyline profile as shown in figure 3-11. These hill masses can be expected to produce clutter, and they may completely obscure observation of the areas beyond them. This information is not used in the preparation of the screening crest profile, but it is useful in preparing the clutter portion of the radar visibility diagram. The skyline profile should be constructed by using the M2 aiming circle or the radar's orienting telescope.

CLUTTER DIAGRAM (see note above). Clutter in each sector to be included in the radar visibility diagram is observed at various elevations, starting 10 mils above the lowest point in the screening crest within that sector and moving up in 15-mil increments until the most favorable operating elevation has been determined. Generally, it is desirable to scan at an elevation as close to the elevation of the screening crest as possible; however, lower scanning elevations usually cause more clutter. Normally, the selected elevation will be the lowest elevation at which the amount of clutter observed is accept-

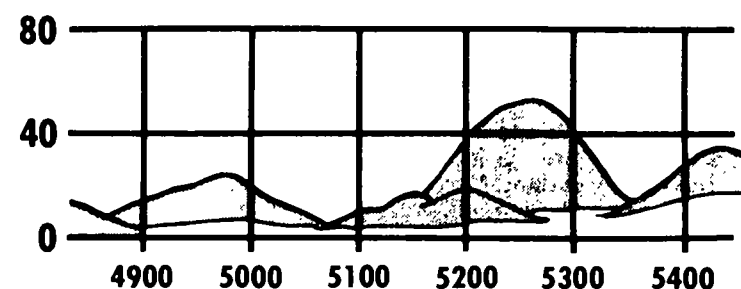
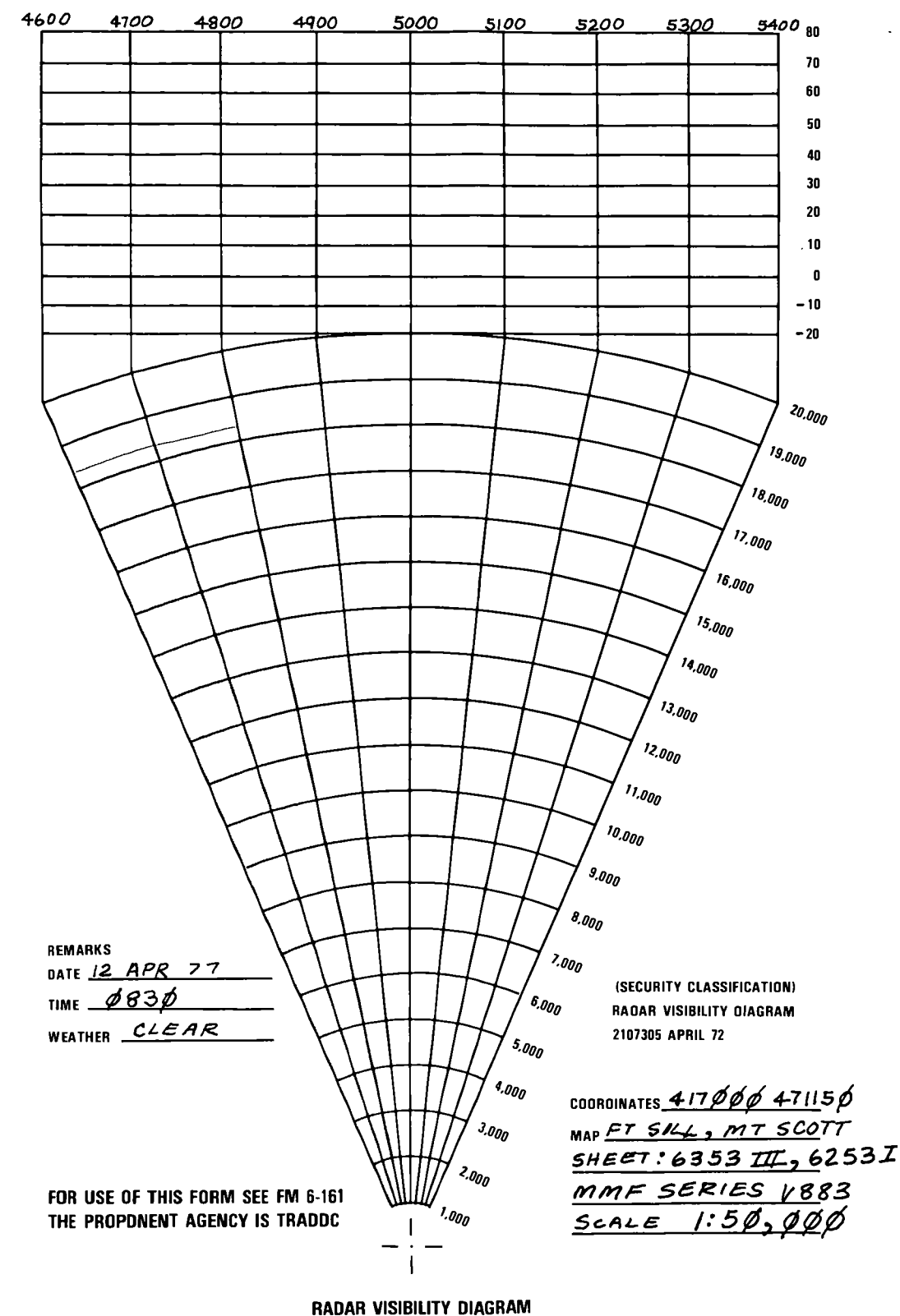


Figure 3-11. Skyline profile seen above screening crest.

able. In any case, the elevation must be at least 10 mils above the screening crest and low enough to enable the radar to perform its assigned mission. During these observations, the IF GAIN control should be set at the normal operating level; if it is anticipated that the circular polarizer will be used at this site, the polarizer should be in the operating position. The clutter portion of the radar visibility diagram (figure 3-12) is prepared in the following manner:

- Place a sheet of tracing paper over the appropriate map and draw in the registration marks and the boundaries (range and azimuth) of the sectors being searched. Do not include marks and boundaries within 1,000 meters of the radar. Identify each sector by placing a letter along the edge of the sector nearest the radar.
- Set the antenna azimuth at the center of one of the sectors, and set the antenna elevation at the elevation chosen for that sector.
- Place the RANGE SELECTOR switch in the 1500 M position, the BEAM VIDEO switch in the BOTH position, and the RANGE SHIFT switch at OFF. Place the detent switch at OFF and the Δ RANGE and Δ AZIMUTH controls in detent.
- Using the LOWER BEAM RANGE and LOWER BEAM AZIMUTH controls, measure the range and azimuth to several points around each patch of clutter.
- Plot these points on the clutter diagram and connect the points for each patch of clutter with a solid line. Shade the areas within these solid lines to indicate that targets in these areas cannot be observed (figure 3-12).
- Using a map and the observations made

Figure 3-12. Typical radar visibility diagram.



during measurement of the screening crest profile, identify the terrain feature that causes the clutter. Determine whether the area beyond the patch of clutter also is obscured. For example, note that in figure 3-11 the hill at azimuth 5250 extends approximately 60 mils above the screening crest. A scanning elevation of 35 mils was selected for this sector; therefore, all returns from objects behind that hill will be cut off. Shade this area to indicate that targets in the area cannot be observed.

Draw a dotted arc in each sector to indicate the maximum range at which 81-mm mortars can be located by the radar. This range varies with the scanning elevation of the radar and with the type of ammunition, charge, and elevation being fired by the mortar. The following ranges are considered representative for the elevations indicated:

Scanning elevation	Maximum effective detection range
35 mils	10,000 meters
40 mils	9,400 meters
50 mils	8,400 meters
60 mils	7,500 meters
70 mils	6,800 meters
80 mils	6,300 meters

Repeat the preceding procedures for each sector included in the clutter diagram.

MARGINAL INFORMATION. The radar visibility diagram overlay must include the following marginal information:

- Security classification.
- Date and time.
- Map references:

Sheet name.
Sheet number.
Map series number.
Scale.

- Prepared by:

Name and rank.
Organization.

- Additional information:

Scanning elevation for each sector.
Explanation of dotted line indicating maximum detection range for 81-mm mortar (when used).

Section VI. OPERATIONS SECURITY

3-27. Countermeasures

The actions taken by the radar section to reduce its imagery and electromagnetic signatures are called countermeasures. As will be discussed, countermeasures can be active, such as use of directional antennas, or passive, such as use of camouflage. The countermeasures discussed in this section apply generally to all FA radar systems.

Reducing Imagery Signature

The visual signature of the radar section can be reduced through good camouflage. To be effective, camouflage must take into account the six factors of recognition—shape, shadow, texture, color, siting, and movement. TC 21-75 covers many of the techniques that the section needs to effectively camouflage its position. Beyond that, deception techniques such as dummy positions and dummy antennas (radar and radio) can be used if directed by higher headquarters.

DECEPTION TECHNIQUES MUST BE CAREFULLY INTEGRATED INTO THE DIVISION'S OVERALL DECEPTION PLAN.

While there is little that can be done to reduce the IR signature of the radar section in the field, care in position selection can help. An aerial platform, such as a helicopter or a reconnaissance jet that overflies the radar position, can detect the section's IR signature if it has been equipped to do so. When positioning the radar, consideration should be given to finding a location that is under the air defense umbrella of a larger unit.

Reducing Electromagnetic Signature

The radar section has two electromagnetic signatures, radar and radio. The greatest OPSEC vulnerability of FA radar systems is the signal intelligence (SIGINT) gained from analysis of colocated radars and radios. The combat intelligence gained from colocated radios and radars is more lucrative than the combat intelligence gained from each source separately. Every effort must be made to deny an enemy this source of information.

RADAR SIGNATURE COUNTERMEASURES.

Several countermeasures can be used to reduce the vulnerability of FA radars to direction finding and analysis.

- **Good maintenance.** Maintaining the radar set in good operating condition helps prevent any unique radiation characteristics that may serve to "fingerprint" the set. Close adherence to equipment specifications during support maintenance and calibration is the key to solving this problem.

- **Reduced operating time.** The shorter the time the radar set is transmitting, the less likely it is that it will be intercepted. A radar that is operating for less than 25 seconds may not be on the air long enough for an enemy intercept operator to identify it and have direction finding stations acquire bearings to the radar set. However, if the radar is operating on a fixed schedule, the enemy intercept operator can have direction finding stations standing by to take bearings to the radar as soon as it comes on the air, which they can do in less than 25 seconds. To avoid operations on a fixed schedule, a cueing system

can be used in which another element (e.g., an observer or the fire direction center) tells the radar section when to transmit in order to detect its target. With such a system, the persons cueing the radars also must understand thoroughly the threat that long transmissions or repeated transmissions pose. Encrypted communications must be used to keep the enemy from being cued also.

- **Antenna orientation during calibration.** Field artillery radars must be calibrated upon occupation of a new position. To keep from disclosing the radar position, calibration should be performed with the antenna oriented to the rear and in an area where there is sufficient masking to prevent the locating of the radar through direction finding of the side or back lobes of the radar radiation pattern.

- **Equipment sharing.** Equipment sharing has limited application to FA radar systems. The concept entails sharing the requirement to observe a certain area among two or more radars. In alternating the radars, the enemy DF stations would be confused, as would order of battle analysts, provided the other ELSEC (electronic security) techniques outlined here are adhered to. However, the number of FA radar systems available within a division compared to the probable frontage across which a US division would be deployed limits the employment of this technique to special situations.

- **Equipment siting, tunneling, and background.**

Tunneling is the name given to the technique of reducing the side, top, and back lobes of the radar radiation pattern by careful site selection. Positioning the radar so that vegetation is above it and to its sides and rear is an example of tunneling. The more vegetation between the radar and the intercept operator, the weaker is the signal the intercept operator receives. Use of tunneling will reduce considerably the risk of being located through direction finding of side-lobe or back-lobe radiation.

Background is the area beyond the target area. Normally, background considerations are associated with moving target locating radars, with one important exception. Backgrounds can

be open, hard, or soft. Open background is the least desirable. If there are no terrain features or vegetation to reflect or absorb the radar beam beyond the target area, the background is open. This is an ideal situation for enemy DF operators. Hard backgrounds reflect radar beams. During the process of reflection, the beam is bent and some phase shifting occurs. A phenomenon known as multipath effect (the receiving of the same signal from different directions and out of phase with each other) makes it very difficult to obtain good direction finding bearings to the radar. However, this does not keep the intercept operation from performing signal analysis. Hard backgrounds are better than open backgrounds but not as good as soft backgrounds.

Soft backgrounds absorb radar radiation. Freshly turned fields and vegetation are soft backgrounds. If a radar set is oriented toward a soft background and is sited to take advantage of tunneling, its vulnerability to intercept and direction finding will be reduced considerably.

Background selection for AN/MPQ-4A radars presents unique problems. To properly track artillery and mortar rounds, the radar must be oriented so that its radar beams go above intervening crests into space. If the radar is sited so that the two crests are between it and a possible enemy direction finding station, part of the radar beam will be refracted by the first crest into the valley between the crests. A portion of the refracted wave will be refracted again by the second crest. This twice-refracted beam cannot be accurately located by direction finding.

- **Radar adjustments.** To reduce the vulnerability of a radar site to hostile detection while preoperational equipment procedures are being performed, the mechanical components of the antenna system must be checked out and adjusted with the transmitter turned off. All transmitter adjustments must be performed in short bursts of not longer than 25 seconds of transmitting time. This includes tuning the local oscillator, range calibration, and ringtime checks. Orientation should be accomplished optically. If the transmitter must be fired, the an-

tenna should be directed into friendly areas, away from enemy-held territory. The rear of the antenna should be protected so that rear and side lobes are suppressed. Considering that hostile radio direction finding (RDF) equipment can locate the radar each time it is fired, the antenna must *never* be slewed in azimuth with the transmitter radiating. After each mission, the transmitter must be turned off immediately. During a radar gunnery mission, such as a high-burst or mean-point-of-impact registration, the operator should fire the transmitter only after he hears the announcement SPLASH. After he marks the round, the transmitter should be turned off.

- **Radar visibility diagrams** (*see note in paragraph 3-26 above*). During preparation of a radar visibility diagram (figure 3-12), the transmitter should only be randomly fired for no more than 25 seconds at a time.

RADIO SIGNATURE COUNTERMEASURES. The second component of the electromagnetic signature is the signature of the radar section's tactical FM radio. Many of the considerations applicable to radars carry over to tactical radio operations; among these are reduced operating time and equipment siting. Other countermeasures include using low power, directional/horizontally polarized antennas, and equipment remoting which are applicable to tactical radios but not to FA radar systems.

- **Reduced transmitting time.** As with radars, it takes an enemy radio intercept operator a certain amount of time to alert his direction finding stations and receive bearings from them. Cutting transmission times to less than the time it takes to find the radar section's radio goes a long way toward defeating direction finding. Transmission times should not exceed 20 to 25 seconds. Transmission times can be shortened by using preformatted messages and transmission authentication. Radio operators and other radio users must be trained to compose their messages before transmitting.

- **Equipment siting and antenna masking.** The objective of antenna masking is to shield the transmission from enemy intercept while maintaining communications with friendly stations. In principle, this is the same

technique described for radar transmission. In seeking to mask radio transmissions from intercept, the selection of background is the same as for the radar. Hard terrain features will reflect and scatter the radio waves and give rise to erroneous direction finding bearings. Soft backgrounds will tend to absorb radio waves. Bear in mind that any error induced in the enemy's direction finding bearings of a radio transmitter will result in location errors, which will make the location almost unusable.

- **Low-power setting.** On low power, an AN/VRC-12 radio can be received by radio direction finders at a distance in excess of 10 kilometers and perhaps as far as 30 kilometers. At high power, these radios can be intercepted at a distance from 30 to 80 kilometers. If low power will reach the intended receiver, use it. Use the smallest antenna that will permit effective communications. Use a directional antenna in preference to an omnidirectional antenna.

- **Directional/horizontally polarized antennas.** Enemy radio direction finding units use Adcock or vertical loop antennas. These antennas are designed to operate best when receiving vertically polarized radio waves (vertical antennas produce vertically polarized waves). Using a horizontal antenna will create some bearing error in the Adcock antenna and large bearing errors in the vertical loop antenna. Horizontally polarized antennas are also directional. This further reduces the enemy's ability to locate tactical radios through direction finding. Details for constructing horizontally polarized directional antennas can be found in TC 11-5, 29 April 1977.

- **Remoting.** The AN/GRA-39 radio set control group allows the radio to be remoted up to 3.2 kilometers from the radar. This serves little practical purpose unless it is done to take advantage of better terrain masking or similar considerations at the remote site. Remoting the transmitter less than 1 kilometer just to separate radio from radar is ineffective, because there are inherent inaccuracies in radio direction finding of about 1 kilometer under battlefield conditions.

Application of the countermeasures outlined above will help protect the radar section from being exploited to provide enemy intelli-

gence officers with combat information and intelligence. They will also provide some help in overcoming enemy jamming.

3-28. Jamming

The radar operator must learn to recognize the different forms of interference and to distinguish unintentional interference from deliberate interference caused by enemy jamming. Unintentional interference may result from the operation of nearby electrical equipment, or it may originate in the radar itself. This interference will, at times, produce patterns on the radar scope similar to the patterns caused by enemy jamming. Interference caused by enemy jamming is indicated when an interference pattern remains on the scope after the interference from all friendly sources has been eliminated. When the operator has observed the interference and determined that it is the result of enemy jamming, the next step is to take all possible action to minimize the effects of the jamming and to continue operation. If, because of enemy jamming, an untrained operator shuts down his set with the mistaken idea that the set is defective, he will be reacting just as the enemy wants him to. Through training and practice, the operator can learn to distinguish unintentional interference from the interference caused by enemy jamming and can take the necessary countermeasures.

Types of Jamming

Jamming is divided into two general categories—transmission jamming, which is produced by a transmitter radiating a modulated or an unmodulated radiofrequency signal, and reflective jamming, which is produced by reflecting devices and is intended to produce false targets or to obscure actual target signals on the radar scope.

TRANSMISSION JAMMING. Usually, transmission jamming has a directional characteristic; that is, the jamming indication is limited to a particular portion of the sector scanned by the

radar being jammed. Depending on the type of transmission used, transmission jamming produces either strobe lines (extreme brightening of the sweep) or sector blanking (complete blanking of all indications) in the direction from which the jamming is being received. However, if the jamming signal is extremely strong, transmission jamming can completely saturate the radar scope, and the direction from which the jamming is being received cannot be determined. From the counter-countermeasure viewpoint, it is important to note the direction of the jamming indication when the jamming does have discernible directional characteristics, so that the jammer can be located and steps can be taken to reduce its effectiveness.

REFLECTIVE JAMMING. Reflective jamming is produced by means of other than active transmitters. Generally, reflective jamming is produced by reflecting items, such as rope, chaff, and straw. These reflecting items (usually in the form of various types, shapes, and sizes of metal-coated paper) are dropped from aircraft. The purpose of reflective jamming is to create false echoes or to produce large echoes, with the intention of shadowing or obscuring target signals. Reflective jamming also is produced by window jamming devices, such as corner reflectors, metallic mesh, and strobe, rotating, or oscillating dipoles. These types of window jamming devices are intended to produce strong false echoes, which will obscure the true target echoes. False echo interference may be called deception instead of jamming. All window jamming devices operate on the same principle, that of reflecting the pulse transmitted from a radar set. Only by intensive training and experience can a radar operator learn to distinguish between true target echoes and those produced by window jamming devices.

Location of Jamming Source

When interference is received and it appears to the radar operator that it is deliberate enemy jamming, he should immediately report to his superior the type of jamming received and the direction from which it is received. The operator also should keep a record of the time, type, and

direction of the jamming signal. Information from two or more radar sites may provide data to establish the general location of the jammer and may determine its movement, if the jamming originates from a moving source. These data can be used as a guide in resiting the radar equipment or may be used to produce fire direction data to place the site of the jammer under active fire with guns, missiles, or aircraft. Jamming should be reported as long as the jamming indication is observed. All suspected or confirmed instances of jamming and interference should be reported in accordance with AR 105-3(C).

Procedure for Operation Against Transmission Jamming

After the type and direction of the jamming have been determined, the following procedures can be used to reduce the effectiveness of the jammer against the radar set AN/MPQ-4A:

GAIN CONTROL. In continuous-wave jamming, a type of electronic jamming, a gain setting less than that used for normal operation is usually most effective. A reduced gain setting prevents overloading the receiver and allows the target echo to be seen through the jamming signal. The GAIN control should be varied over its entire range to find the setting at which the target echo is best seen. However, if continuous-wave jamming is strong enough to block the receiver completely, the GAIN control will not effectively reduce the jamming effects.

LOCAL OSCILLATOR. Varying the local oscillator tuning a small amount may help to reduce the effects of continuous-wave jamming if the jamming signal is confined to a narrow frequency band. Modulated jamming, however, usually produces a signal of sufficient bandwidth to make varying the local oscillator ineffective as an anti-jamming measure.

SITING. The AN/MPQ-4A radar is difficult to jam unless a line-of-sight condition exists between the jammer and the radar. Therefore, it is important that the radar be located in defilade.

ANTENNA ELEVATION. If jamming occurs only when the jammer is in the main lobe of the radar, some relief may be obtained by increasing the elevation angle of the antenna. Even though

the Δ time will be increased, the information obtained from the computer will still be usable.

Procedure for Operation Against Reflective Jamming

To counter window jamming, adjust the INTENSITY, FOCUS, and IF GAIN controls for maximum definition. Usually, window jamming indications appear as many closely spaced targets (clutter). Good definition helps to sep-

arate the true target echoes from the jamming echoes and makes it easier to follow the movement of the target indication through the random movement of the jamming echoes on the scope.

Additional relief from the effects of reflective jamming (particularly rope, chaff, and straw) may be gained by inserting the circular polarizer MX-2219/MPQ-4A. However, since the circular polarizer reduces the effective range of the radar, it should not be employed unless a reduction in the jamming is noticed.

Section VII. AIRLIFTING THE AN/MPQ-4A RADAR AND ANCILLARY EQUIPMENT

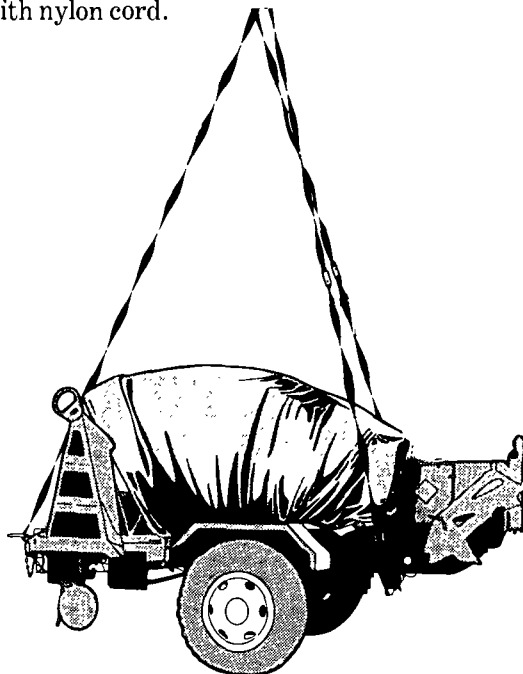
3-29. General

Normally, the radar set and associated equipment are transported as three loads. The radar set and the generator set are transported as sling loads by medium helicopters and the remaining section equipment is loaded onto a ¼-ton trailer carried as an internal load by a CH-47 helicopter or as a sling load by a UH-1 or larger helicopter (units not authorized ¼-ton trailers must make other suitable arrangements). The radar trailer, with the 55-gallon drum of gasoline, weighs 6,640 pounds; the generator trailer weighs 4,680 pounds; and the loaded ¼-ton trailer weighs approximately 1,080 pounds.

3-30. Preparing the Radar Trailer

Four men can prepare the radar trailer in 10 minutes, using 550-pound-capacity nylon cord as required. Secure the trailer in the march-order configuration. Place the 55-gallon drum of gasoline on the A-frame, to the rear of the

lunette, and lash it down with nylon cord (the weight of the drum prevents the trailer from pitching backward when the rear outrigger arm is raised to the travel position). Raise and secure the rear outrigger for travel. Fasten the intervehicular electrical cable, airhoses, and safety chain to appropriate brackets and secure them with nylon cord.



3-31. Rigging the Radar Trailer (see figure 3-13)

Two men can rig the radar trailer in 10 minutes using two large clevis assemblies; three type IV link assemblies; one 3-foot, 3-loop aerial delivery sling; two 8-foot, 3-loop aerial delivery slings; two 9-foot, 3-loop aerial delivery slings; one 20-foot, 3-loop aerial delivery sling; one 16- to 20-foot tag line; and 2-inch adhesive tape as required. Using figure 3-13 as a guide, rig the load as follows:

To form sling leg 1, choke-hitch the 20-foot sling to the lunette by placing one end of the sling over the top of the neck and bringing the free end up through the eye of the lunette.

To form sling leg 2, attach the bell of a large clevis assembly to one end of an 8-foot sling. Attach the bolt of the clevis assembly to the *left* rear lifting bracket of the radar trailer. Attach a 9-foot sling to the 8-foot sling with a link assembly.

To form sling leg 3, attach the bell of a large clevis assembly to one end of an 8-foot sling. Attach the bolt of the clevis assembly to the *right* rear lifting bracket of the radar trailer. Attach a 9-foot sling to the 8-foot sling with a link assembly.

Twist each sling leg, one twist for every 3 feet of sling length. Pass one end of the 3-foot sling through the upper ends of legs 3, 1, and 2, in that order. Connect the ends of the 3-foot sling with a link assembly to form a ring.

Draw the three legs together at the top center of the load and weave them together with several turns of tape. About halfway between this wrap and the 3-foot sling, again wrap all three legs with several turns of tape. Wrapping the legs will prevent them from becoming tangled prior to hookup.

Attach one end of the 16- or 20-foot tag line to the lunette of the trailer.

come into contact with the cargo hook. Positive control and coordination is required to accomplish hookup and to insure that the pilot allows time for the hookup man to clear the load before lift-off.

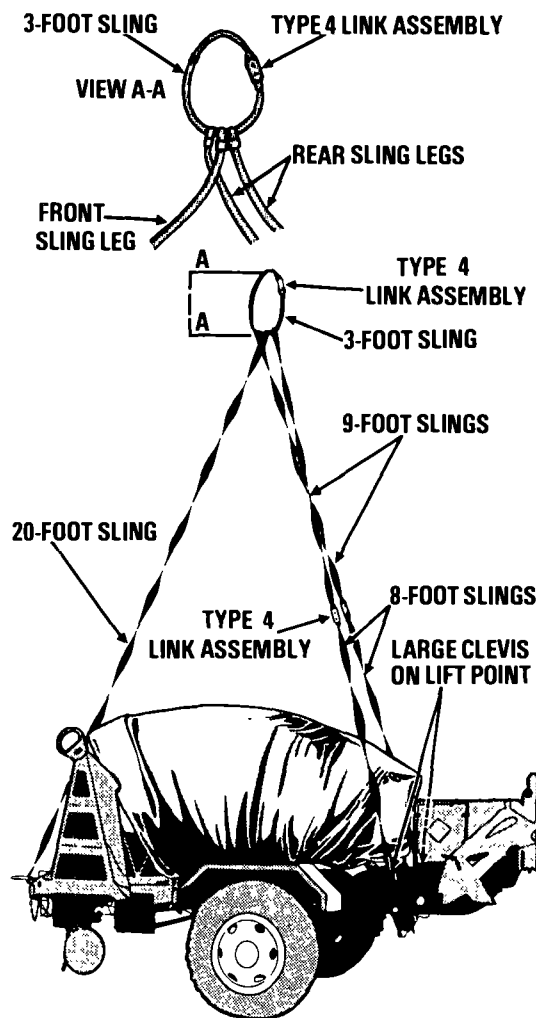


Figure 3-13. Rigging diagram for radar set AN/MPQ-4A.

Note. The hookup man must stand on the load to place the 3-foot ring in the helicopter cargo hook. He must make certain that the link assembly does not

3-32. Preparing the Generator Trailer

Two men can prepare the generator trailer in 10 minutes, using 550-pound-capacity nylon cord as required.

Place the generator trailer in the march-order configuration.

Remove the canvas and bows. Usually, these items will not be taken on an airlifted mission.

Substitute five water cans and one oil can for the six gas cans normally carried in the trailer.

Secure all components in the trailer (strap, tape, and tie down as required).

Disconnect the negative terminal from the generator battery and tape it to prevent shorting.

Fasten the intervehicular electrical cable, airhose, and safety chains to appropriate brackets and secure them with nylon cord.

3-33. Rigging the Generator Trailer (see figure 3-14)

Two men can rig the generator trailer in 10 minutes, using two large clevis assemblies; one type IV link assembly; one 3-foot, 3-loop aerial delivery sling; three 20-foot, 3-loop, aerial delivery slings; and 2-inch adhesive tape and padding material as required.

Rig the trailer, generally following the procedure described in paragraph 3-31.

Check carefully for untaped or unpadded areas that could damage the slings. Pad and tape the slings or the load to prevent damage.

3-34. Preparing the ¼-Ton Trailer

Essential plotting equipment, communication equipment, and test equipment are loaded

into the ¼-ton trailer. The load must be carefully packed and padded as necessary to prevent damage.

If the trailer is to be carried as a sling load, it should be prepared and rigged as described in paragraphs 7-1 through 7-4, TM 55-450-11.

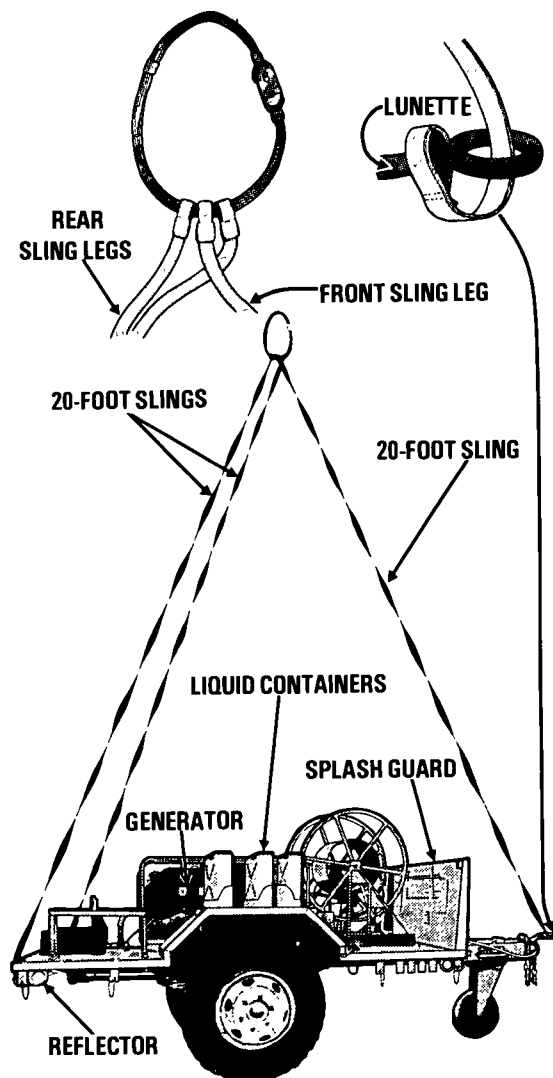


Figure 3-14. Rigging diagram for generator trailer PU-304C.

3-35. Derigging the Radar and Generator Trailers

Two men can derig each trailer in 5 minutes. Manually disconnect the slings, starting with the 3-foot ring, and stow all sling materials in a sling bag.

CHAPTER 4

MOVING TARGET LOCATING RADAR SET AN/TPS-25A

Section I. Organization and Operation

	Paragraph		
Organization of Moving Target Locating Radar Section	4-1	Technical Considerations	4-7
Duties of Personnel	4-2	Site Evaluation	4-8
Organization of Personnel for Operation	4-3	Section III. Airlifting the AN/TPS-25A and Ancillary Equipment	
		Airlifting Radar Set AN/TPS-25A	4-9
Section II. Tactical Employment and Position Requirements		Rigging the Shelter	4-10
General	4-4	Derigging the Shelter	4-11
Selection of Radar Site	4-5	Airlifting Radar Set AN/TPS-25A Shelter in Trailer	4-12
Tactical Considerations	4-6	Rigging the Load	4-13

Section I. ORGANIZATION AND OPERATION

4-1. Organization of Moving Target Locating Radar Section

There is one AN/TPS-25A or AN/TPS-58 radar section in each target acquisition battery. The AN/TPS-25 has a seven-man crew. Normally, the division artillery tactical operation center (TOC) will site and control the operation of the radar. To reduce the radar's vulnerability (it is an active transmitter) and to increase its effectiveness, the division artillery TOC will dictate when it is to radiate and the area it is to be oriented toward.

4-2. Duties of Personnel

The principal duties of personnel in a moving target locating radar section of a target acquisition battery are listed below:

Radar Technician

Advises commander and staff on equipment capabilities and employment. Performs reconnaissance to determine actual site. Coordinates the activities of all radar personnel in their respective duties.

Section Chief

Supervises operation and maintenance of the radar equipment, assists the radar technician, and evaluates site after occupation of position.

★ *Field Artillery Radar Repairer*

Performs organizational maintenance and repair of radar equipment and assists the radar technician.

Senior Field Artillery Radar Operator

Operates and supervises the operation of the radar set, assists in the emplacement and concealment of the radar, and assists the section chief in all of his duties.

Radar Operator (Two)

Operates the radar using the controls on the radar set control unit.

Operates and performs user maintenance on communication equipment utilized in the radar section.

Operates the radar's prime movers and performs scheduled maintenance on the prime movers. Provides local security and performs other duties assigned by the chief of section.

Power Generator Operator/Mechanic

Operates and performs operator and organizational maintenance on the power generator, provides local security, and assists in the operation of the radar set during periods of intense enemy weapons activity.

4-3. Organization of Personnel for Operation

A well-trained crew is essential to insure accurate and timely location of enemy targets. Continuous operation may be required during combat; therefore, every man in the section must be capable of performing each of the duties necessary to obtain and process enemy targets.

During continuous operation, the section should be organized into two-man teams. To prevent fatigue, the team members should alternate their duties so that no one individual serves as control unit operator for more than 30 minutes at

a time. When the teams are changed, the personnel on duty should be relieved one at a time. This

will allow each person to become familiar with the situation as he assumes his duty.

Section II. TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

4-4. General

The tactical employment and position requirements for the moving target locating radar set will depend on the tactical mission assigned the radar section and on the technical and tactical factors that must be considered to insure maximum effective operation. The complete suitability of a radar site, however, can be determined only by operation from that site.

4-5. Selection of Radar Site

The primary considerations in selecting a radar site are the primary mission of the radar section and the technical capabilities and limitations of the radar set.

In the division artillery, the general position area within which the target acquisition battery commander may select positions is designated by the division artillery TOC. The area should be large enough to enable the field artillery radar technician or chief of section to select the actual radar site on the basis of technical considerations affecting the operation of the radar. The position selected should simplify communications, facilitate survey and logistics, and enable the section to take advantage of any defensive perimeter. Depending on the mission, terrain, and situation, the radar position area should be located from 1,000 to 2,000 meters behind the forward edge of the battle area. This location would give the radar section flexibility of action in both the offense and the defense. Dur-

ing an offensive action, the position should be well forward to avoid early displacement. In the defense, the position should be farther to the rear to reduce the number of displacements of the radar.

After being informed of the general area in which to locate the radar, the radar technician or chief of section will make a reconnaissance prior to selecting the actual position. If time permits, this reconnaissance will be divided into two phases: map reconnaissance and a ground reconnaissance.

The map reconnaissance is made to determine, but is not limited to, the following:

- Routes of approach into and out of the area.
- Identifying landmarks.
- Adjacent units.
- Possible radar positions.

A ground reconnaissance should follow the map reconnaissance in order to insure a rapid occupation of the selected position. The ground reconnaissance is based on the tactical and technical considerations that influence radar operations, and it enables the radar technician or chief of section to make decisions and issue orders concerning the following:

- Exact location of the radar.
- Location of the generator.
- Location of the vehicles.
- Routes of entrance to and exit from the area.
- Searching and marking the area for mines.

- Local security (to include camouflage and defense against air and ground attack).
- Selection of alternate positions.

Note. The above list is not all-inclusive and should be modified as required by the particular mission, situation, and terrain. Normally, the time for reconnaissance is limited. The reconnaissance must be organized so that it can be accomplished in the allotted time.

4-6. Tactical Considerations

Tactical considerations are the same for selecting a radar site as those for choosing a position for a field artillery firing battery or similar unit. The main tactical considerations are discussed below:

ACCESSIBILITY. The radar site must be accessible by road, air, or both, depending upon mission requirements.

COMMUNICATIONS. The communications requirements will vary, depending on the mission assigned to the radar section, but the site must permit the required communications to be established. Wire and/or radio are normal means of communication for the radar section. A typical communications diagram for a moving target locating radar section is shown in FM 6-10.

CONCEALMENT. In selecting a site for the radar, advantage must be taken of natural concealment, such as trees and shrubs. (Concealment must be light enough to not interfere with the radar beam.)

COVER. The radar, with the exception of the antenna, must be emplaced in defilade to the enemy to afford personnel and equipment all possible protection from hostile fire.

ROUTES OF APPROACH. The site selected should have more than one covered route of approach, preferably routes that will allow occupation that is unobserved by the enemy. Road conditions, overhead clearances, bridges, and stream fords also must be considered.

SECURITY. The radar technician or chief of section should attempt to locate a site within an adjacent unit's perimeter of defense. This will ease his local security problems.

SURVEY. The closer the radar site is to a known survey point, the more rapidly survey personnel or organic personnel can determine the coordinates and altitude of the radar and the azimuth and elevation to a known point for orientation purposes.

LOGISTICAL SUPPORT. The radar technician, or the section chief, should attempt to locate the radar within or near an adjacent unit's area and should establish liaison with the unit commander. Such a location would facilitate logistical support for the radar section (e.g., messing and resupply).

Frequently, the moving target locating radar set will be emplaced during darkness or periods of poor visibility. Consequently, tactical considerations, such as communications, survey, local security, and routes of approach, will require a great deal of planning and preparation. As visibility improves, camouflage and concealment will become an important consideration. Cover from enemy fire will be virtually nonexistent for the antenna, since the radar set requires line of sight to the target area.

4-7. Technical Considerations

The technical considerations in selecting a radar site are as follows:

Line of sight to the target area is a mandatory requirement for the antenna location. The antenna is 25 feet above the ground when it is installed on three mast sections. It can be employed with one, two, or three mast sections, or it can be installed directly on the transmitter-receiver.

A suitable location for the shelter (or its contents, if the set is operated outside the shelter) must be selected within 225 feet of the receiver-transmitter. Two 100-foot cables and

one 25-foot cable are provided for connecting the receiver-transmitter and the shelter or coordinator and permit a maximum separation of 225 feet between the two components. Further consideration must be given to locating the power unit within 100 feet (the length of the power cable) of the shelter or power supply (when the set is operated out of the shelter).

The power unit should be located so that the noise and smoke will not disturb the radar operator and so that the unit cannot be located easily by the enemy.

The site selected must be close enough to the area of interest to enable the radar to detect the type of target specified by the mission.

The target aspect should be considered in siting the radar equipment. The AN/TPS-25 radar only detects the movement of an object when the object moves in range, and the detection of motion is much easier when the motion is directly toward or away from the radar.

4-8. Site Evaluation

Since the overriding technical consideration in the selection of a radar site for moving target detection is electronic line of sight, the radar technician or section chief should, before occupying a radar site, construct a hasty visibility profile to determine whether the assigned target area can be covered by the radar set. Effective use of a profile can save valuable time by exposing a useless position.

After a position is occupied, a more detailed visibility profile can be developed into a visibility diagram. This overlay is provided to the division artillery TOC for construction of a target acquisition capabilities chart. A copy of the overlay is also placed at the radar plotting table for the operator's use. The number of copies will be designated by unit SOP.

The evaluation of a radar site to determine its probable suitability for the detection and location of moving ground targets can be accomplished by constructing a series of profiles. From

the profiles, a visibility diagram can be constructed to show the areas that are masked or hidden from the radar. Since the area of interest assigned to the radar section may cover a wide angle, a map study should be made of the area. Close attention should be given to points of interest, such as roads, road junctions, and possible points of troop concentration, in the area of responsibility.

The study of landforms by a visual examination of the contour lines is adequate for many purposes, but a profile usually is required when precision is demanded. A profile is an exaggerated side view of a portion of the Earth's surface along a line between two points.

To plot the masked or hidden areas, a series of profiles must be made through the area of interest. The number of profiles to be drawn will be determined by the terrain and the assigned area of interest. (The example in this manual shows a series of three profiles.) Profiles must be constructed in a series by starting at one edge of the assigned sector and placing one profile below the other. The forward and rear limits of the masked areas then can be determined by drawing straight lines from the radar position to and past the highest points on the profile. When the masked areas have been determined, they can be projected to a horizontal plane by extending the visible points on the profiles to an overlay as shown in figures 4-1, 4-2, and 4-3.

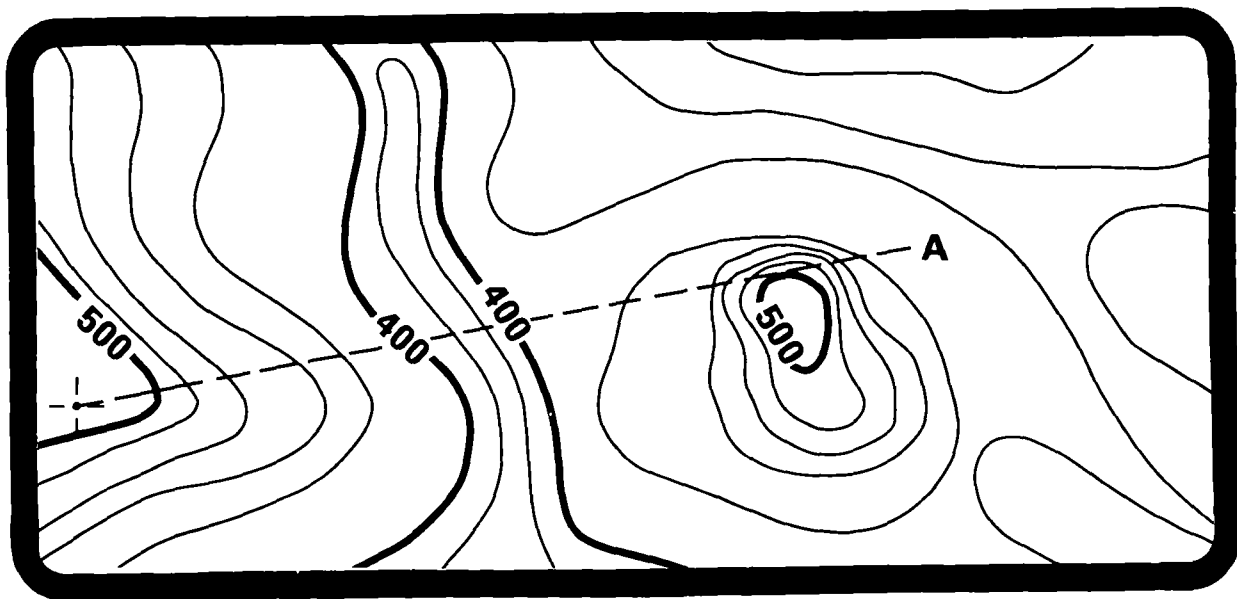


Figure 4-1. Map and profile line.

A profile can be constructed from any contour map, but only along a straight line. The procedure is as follows:

(1) Draw a straight line on the map between the two points along which the profile is desired (figure 4-1). This is the profile line.

(2) Determine by examination the values of the highest and lowest contour lines that cross or touch the profile line. Add one contour value above the highest contour line, and add one below the lowest contour line to account for hills and valleys.

(3) On a blank sheet of paper, draw *equally* spaced horizontal lines. Draw enough lines so there will be one line for each contour value determined in (2) above. Do this for each profile line as shown in figure 4-2.

(4) Place the lined paper on the map with the top line adjacent and parallel to the profile

line.

(5) On the lined paper, number the line closest to the profile line with the highest value determined in (2) above.

(6) Number the rest of the lines in sequence down to the lowest value on the line farthest from the profile line.

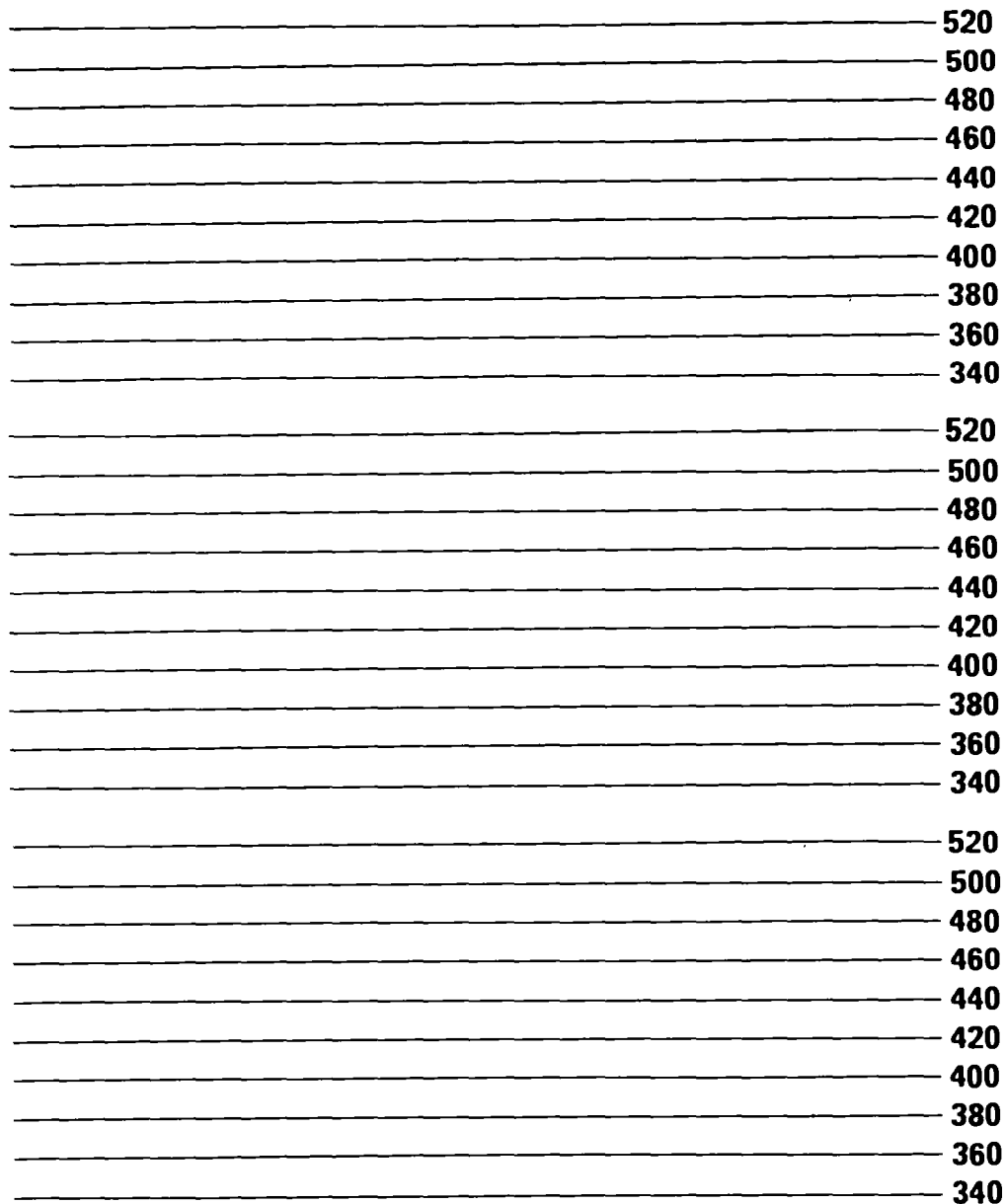
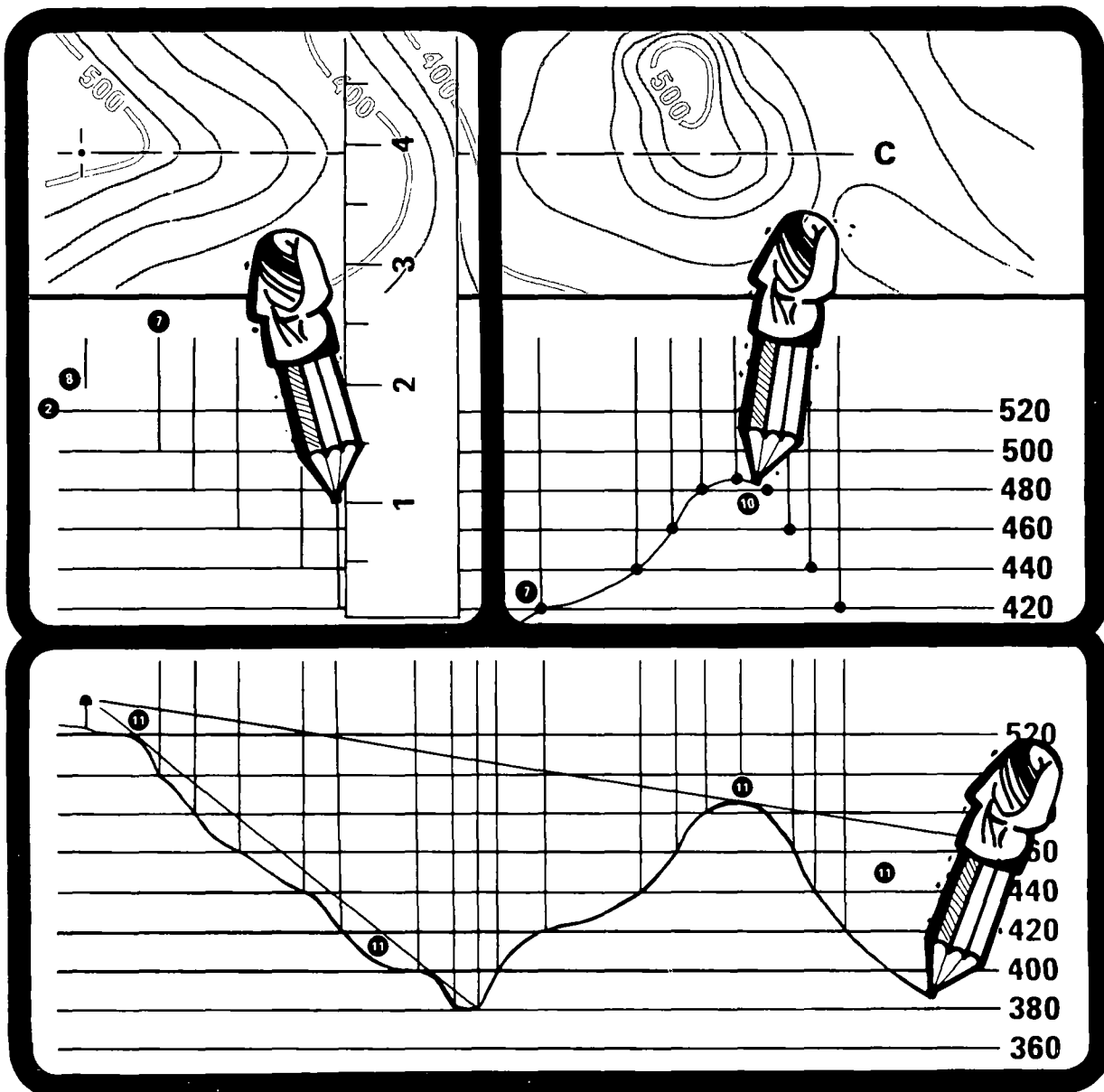


Figure 4-2. Lines for construction of visibility profile.

(7) From each point where a contour line crosses or touches the profile line, draw a perpendicular line to the line with the same value as the contour line. Place a tick mark where the perpendicular line crosses the line (figure 4-3).

(8) Determine the highest point of a hill and the lowest point of a valley by interpolation. Draw a perpendicular line to the interpolated values.

(9) Compute the second profile in the same manner as the first. Move the straightedge clockwise from the first profile line and look for major contour changes in the terrain. When a contour line is crossed that might block the visibility between the radar site and the area of interest, hold the straightedge at this position and plot the points as previously explained. Continue the procedure until the complete area of



interest has been inspected. The number of profiles drawn to any one area may vary from two to a great number, depending on the terrain and the width of the area.

(10) After all perpendicular lines have been drawn on the lined paper, connect all tick marks with a smooth, natural curve following the contour of the terrain as shown in figure 4-3. Usu-

ally, hills and valleys are rounded and streams form a sharp V-shape. Figure 4-3 shows the lined paper placed adjacent and parallel to the profile lines for the construction of the final profile.

(11) Lay a straightedge from the radar position across the top of each ridge and shade in the areas beyond the ridges and below the straightedge (figure 4-3).

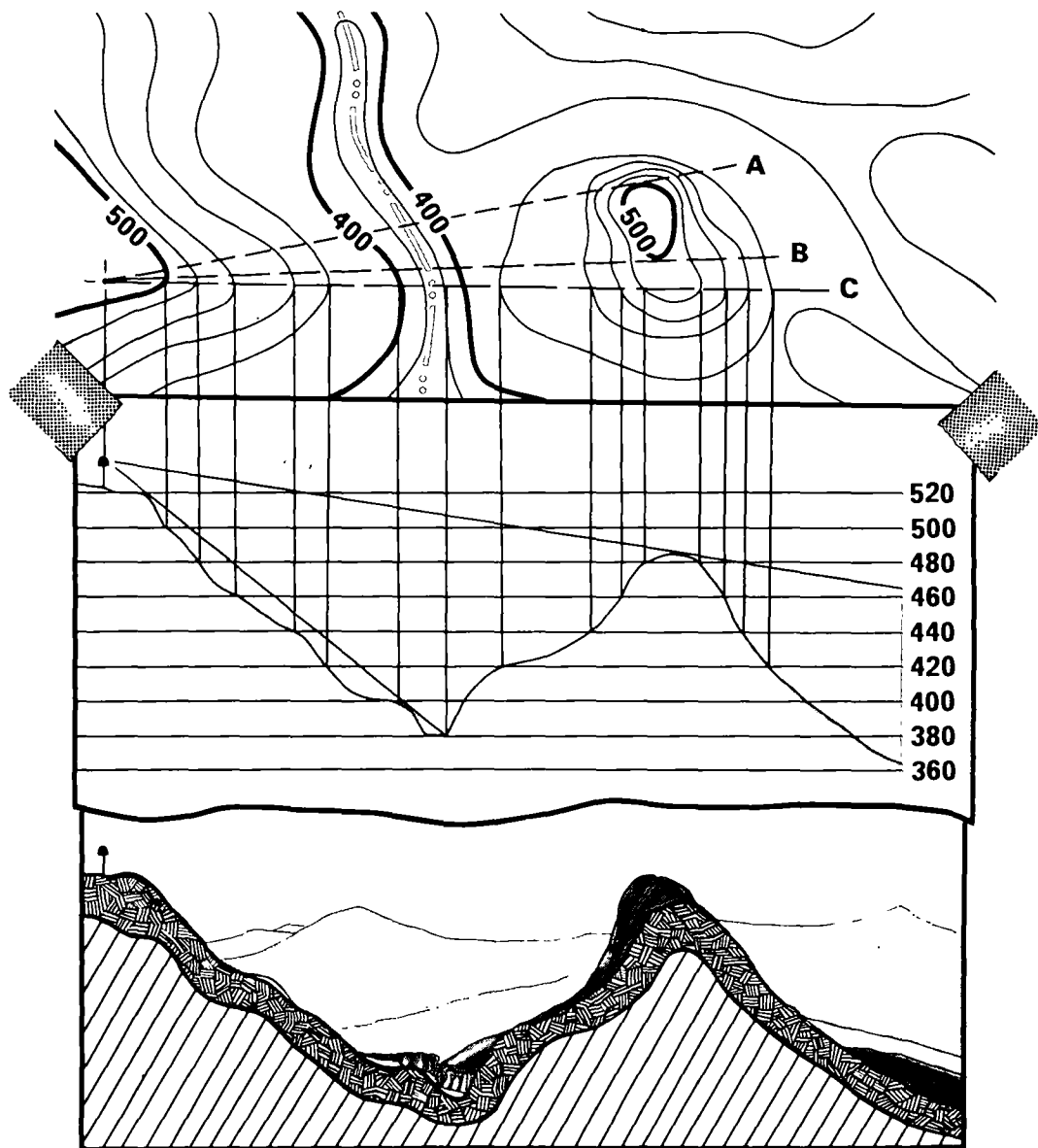


Figure 4-3. Series of visibility profiles (part I).

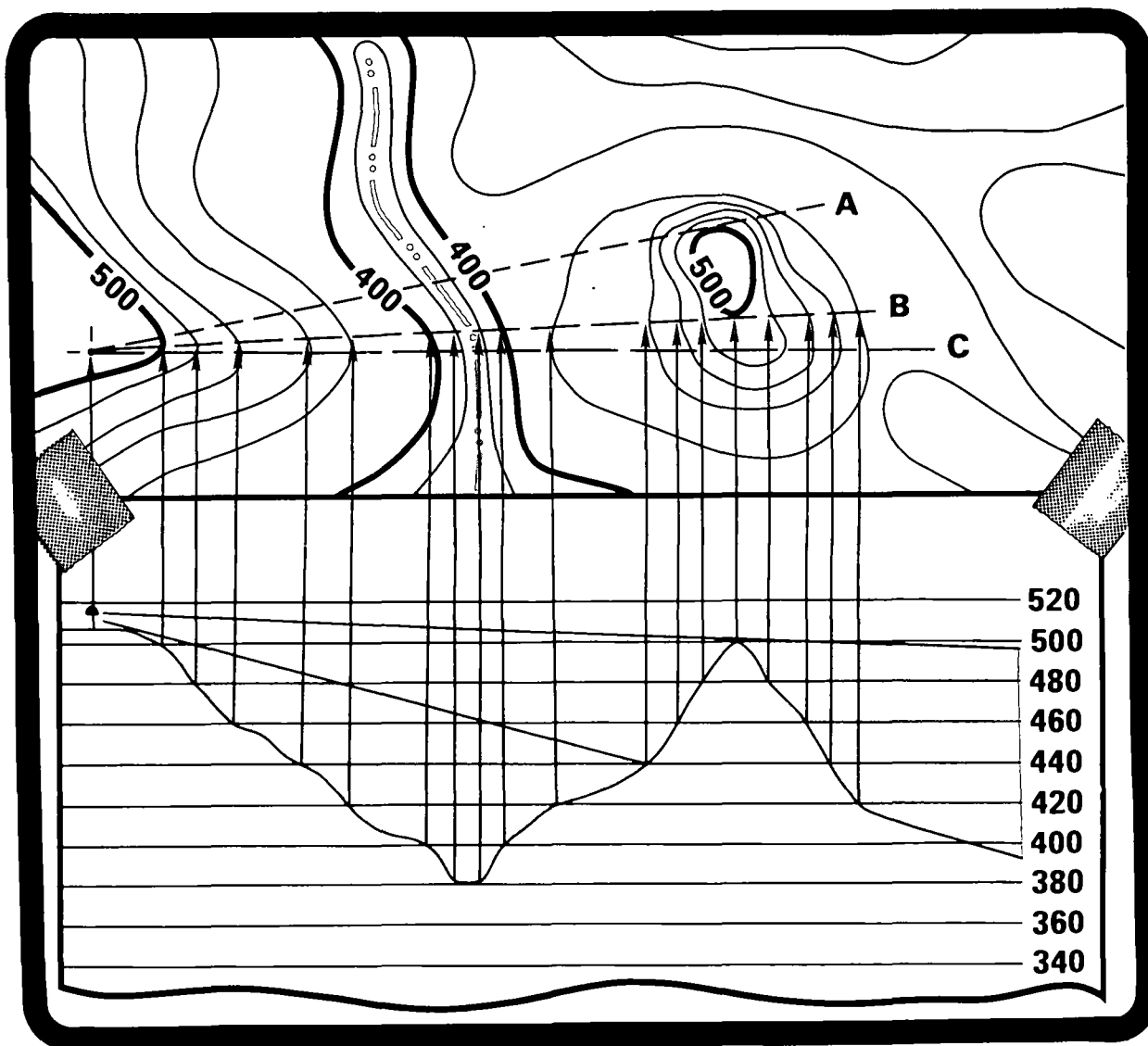


Figure 4-3. Series of visibility profiles (part II).

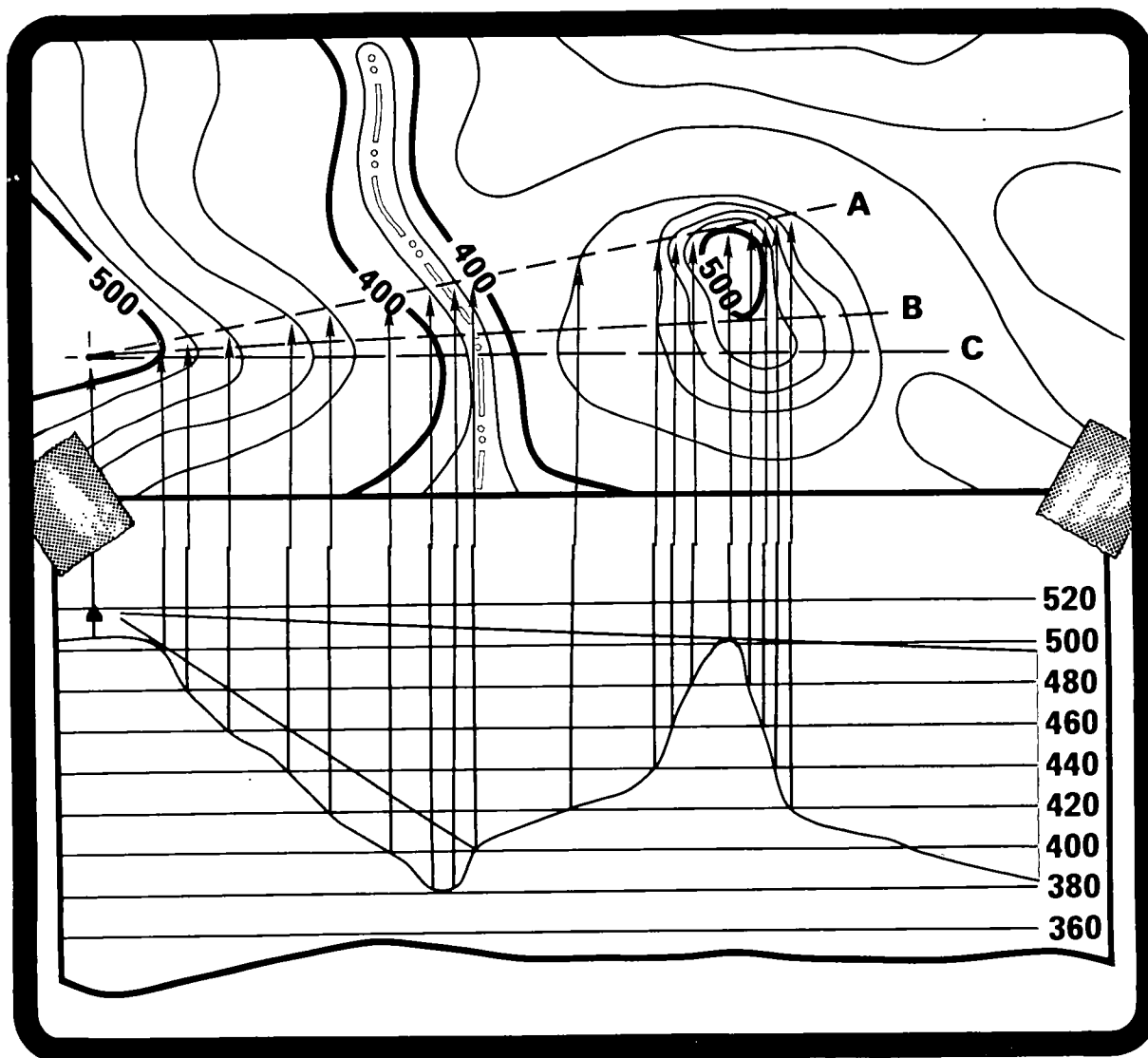


Figure 4-3. Series of visibility profiles (part III).

When speed is the most important element or where a complete profile is unnecessary, a profile may be constructed that shows only the hilltops and ridgetops and, if desired, the valleys. This is called a hasty profile. It is constructed in the same manner as a full profile.

A radar visibility diagram shows the areas that are masked or hidden from the radar. It is

constructed on overlay paper from a series of visibility profiles in the following manner:

(1) Plot a tick mark on one edge of the overlay to represent the radar position.

(2) Measure the angle from the radar position to either side of the area to be searched and to each profile line, and plot these points on the overlay (figure 4-4).

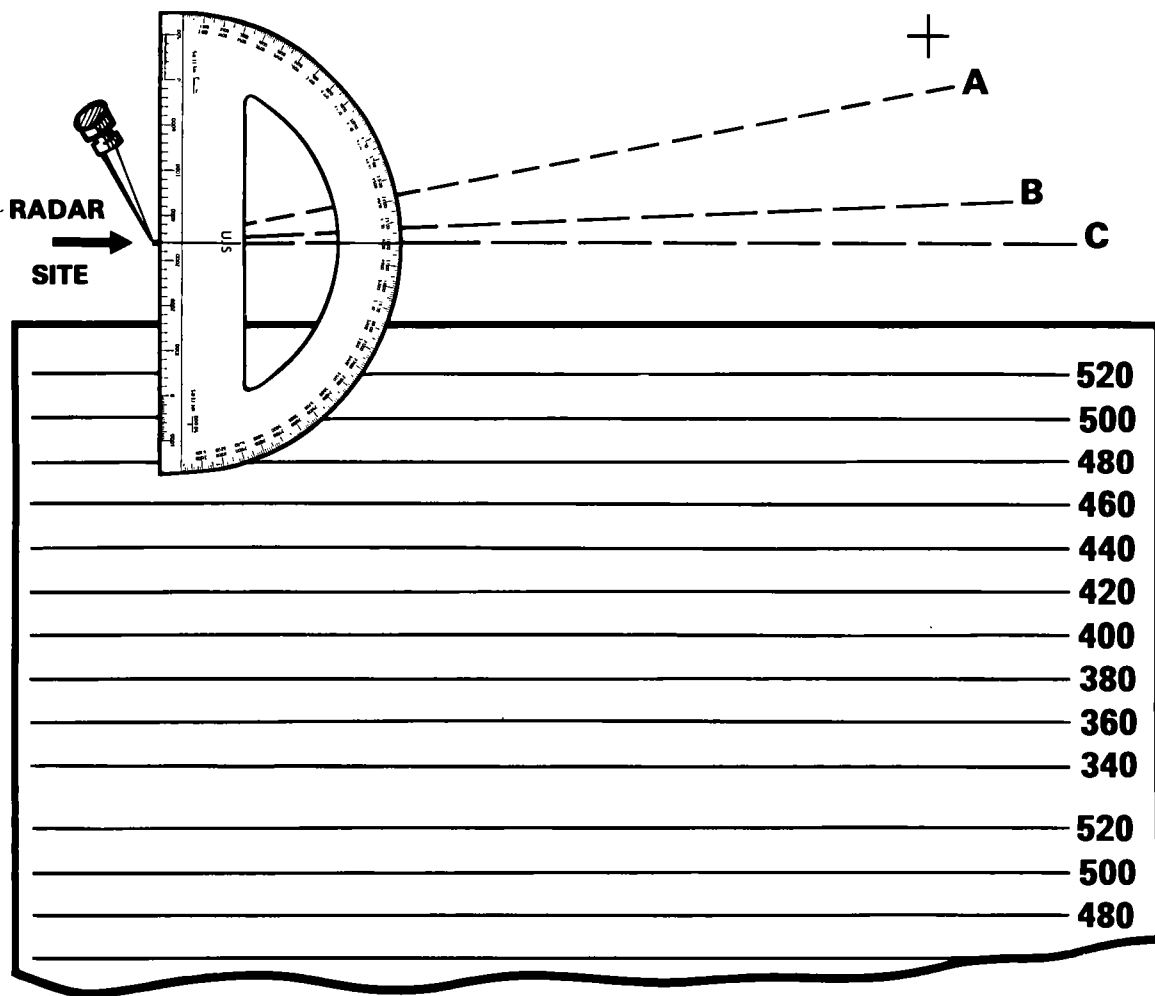


Figure 4-4. Coverage overlay.

(3) Lay the first profile at the top of the scale along the left edge of the angle plotted in (2) above.

(4) Plot a point on the overlay at the end of each of the vertical lines marking the front and rear limits of the masked or shaded areas that

appear along the top profile, and draw a straight line between these points.

(5) Repeat the step in (4) above for each profile. The result should be a series of marks representing the masked area along each profile (figure 4-5).

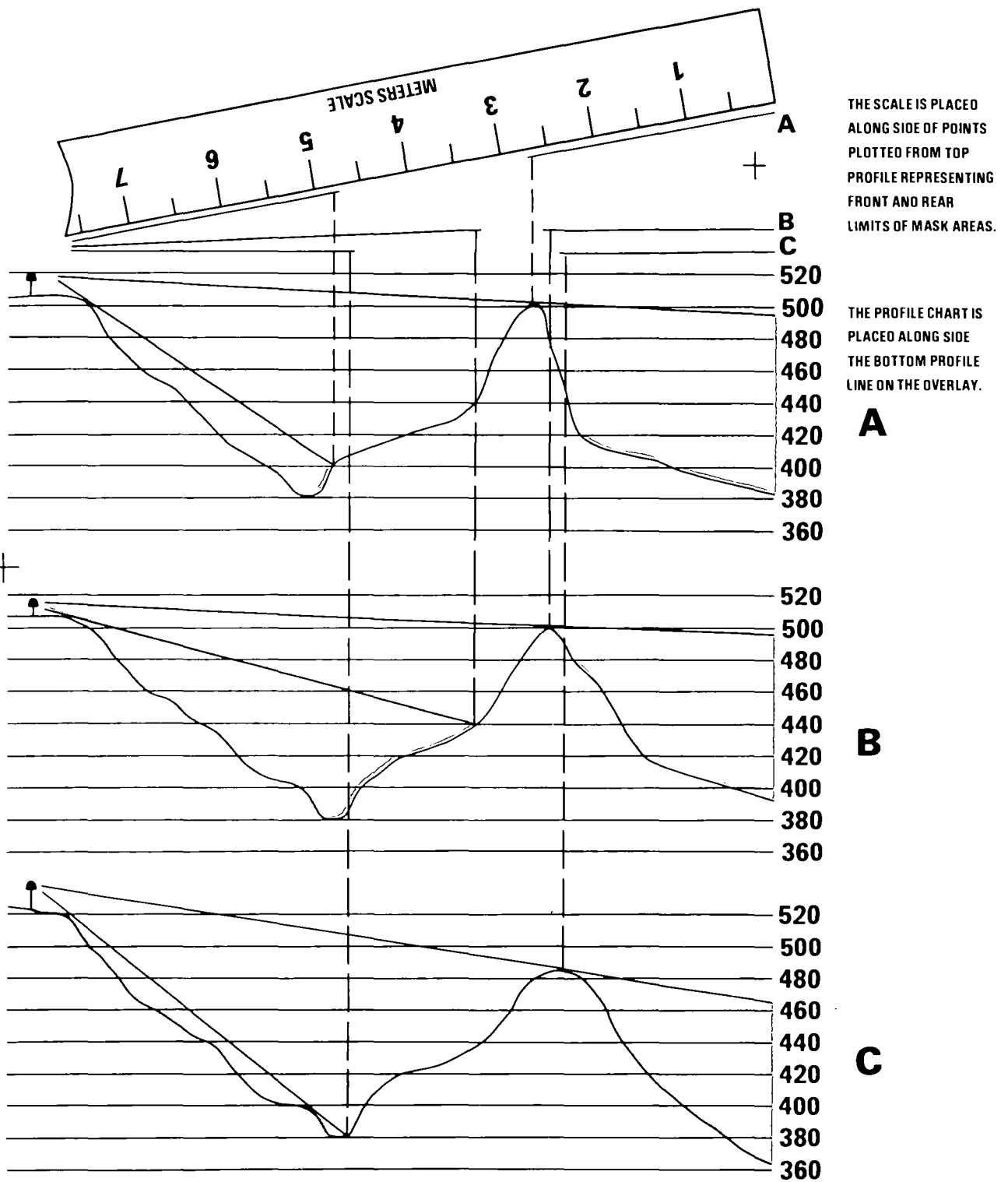


Figure 4-5. Construction of radar visibility diagram.

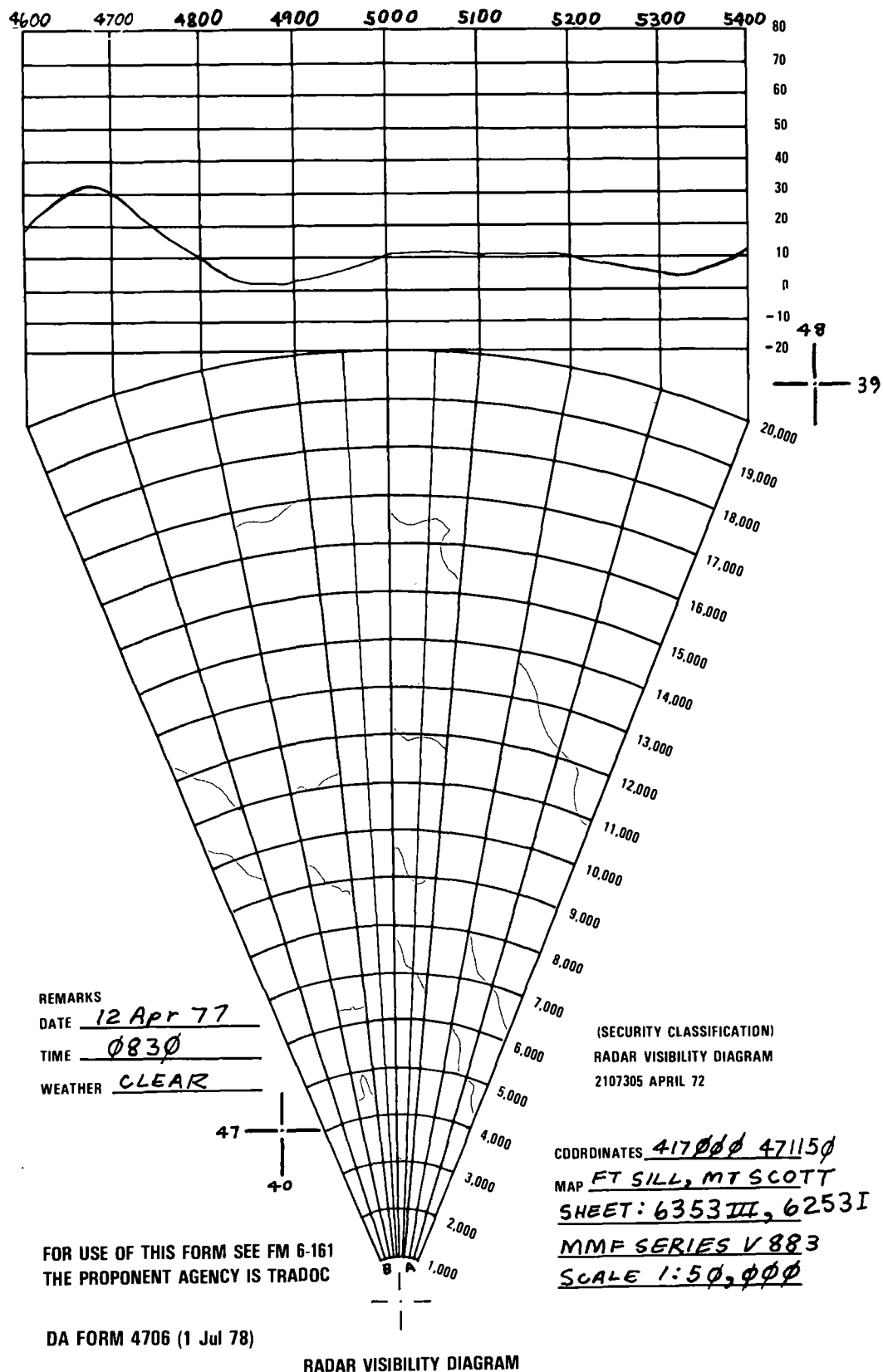


Figure 4-6. Typical radar visibility diagram.

(6) Connect the ends of the lines in each profile representing the shaded areas to the adjacent profiles, and then shade in the area between the profiles to show the terrain that is in defilade to the radar.

(7) The procedures in (1) through (6) above are performed on each area of interest. Transfer this information to a radar visibility diagram (figure 4-6). When the marginal information has been entered on the diagram, it is ready to be submitted to division artillery.

Section III. AIRLIFTING THE AN/TPS-25A AND ANCILLARY EQUIPMENT

4-9. Airlifting Radar Set AN/TPS-25A

The radar set must be in the march-order configuration (that is, the components must be stowed inside the shelter) for transport. Two men can prepare the load in 10 minutes, using four small clevis assemblies, 50-pound-capacity nylon cord, and 2-inch adhesive tape as required. The procedure is as follows:

Secure the cans of gasoline to the racks on the rear of the shelter.

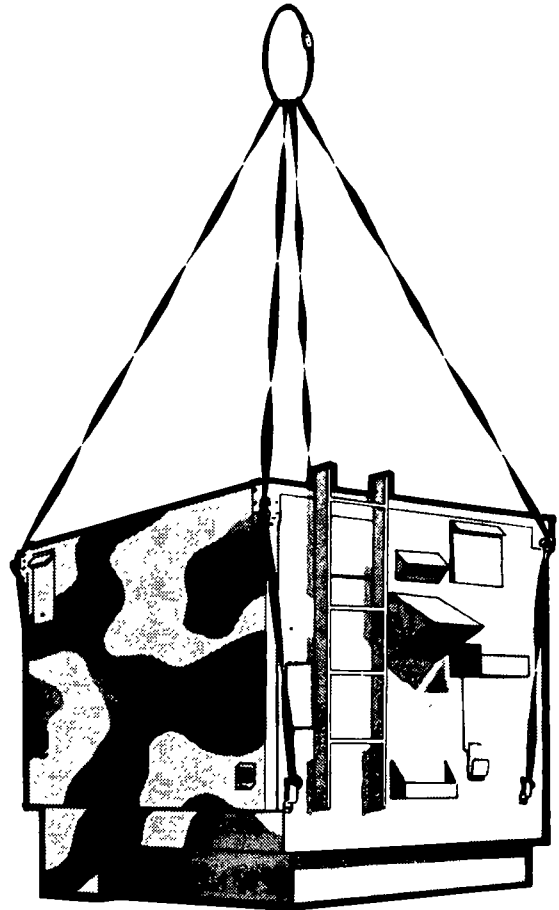
Note. Five gallons of gasoline and 5 gallons of oil are sufficient for approximately 15 hours of operation for the generator, DOD Model MEP-021A.

Install four small clevis assemblies, one on each of the four top lifting brackets of the shelter.

Close and lock the doors.

4-10. Rigging the Shelter (see figure 4-7)

Two men can rig the shelter in 10 minutes, using four large clevis assemblies; four 20-foot, 3-loop aerial delivery slings; one 3-foot, 3-loop aerial delivery sling; one type IV link assembly; and 2-inch adhesive tape and padding material as



required. Using figure 4-7 as a guide, rig the shelter as follows:

Prepare four sling legs, one on each corner of the shelter, as follows: Insert the bolt of a large clevis assembly through the tiedown bracket. Attach one end of a 20-foot aerial delivery sling to the bell of the large clevis assembly and pass the free end of the sling through the small clevis assembly attached to the top lifting bracket of the shelter.

To form a ring when attaching the legs to the 3-foot sling at the top, twist all legs so that there is one twist for every 3 feet of sling length; pass one end of the 3-foot sling through the upper ends of legs 1, 2, 3, and 4; and connect the ends of the 3-foot sling with a link assembly.

To prevent fouling of slings before hookup, draw all four legs together at the top center of the load and wrap the legs with several turns of tape.

CAUTION: Check carefully for untaped or unpadded areas that could damage the slings. Pad and tape the slings or shelter as necessary to prevent damage.

4-11. Derigging the Shelter

Two men can derig the shelter in 5 minutes. Manually disconnect the slings, remove the clevis assemblies, and stow the sling materials in a sling bag.

Note. Generator set MEP-021A can be strapped down on top of the shelter for airlift.

4-12. Airlifting Radar Set AN/TPS-25A Shelter in Trailer

Two men can prepare the load in 15 minutes, using four small clevis assemblies, four

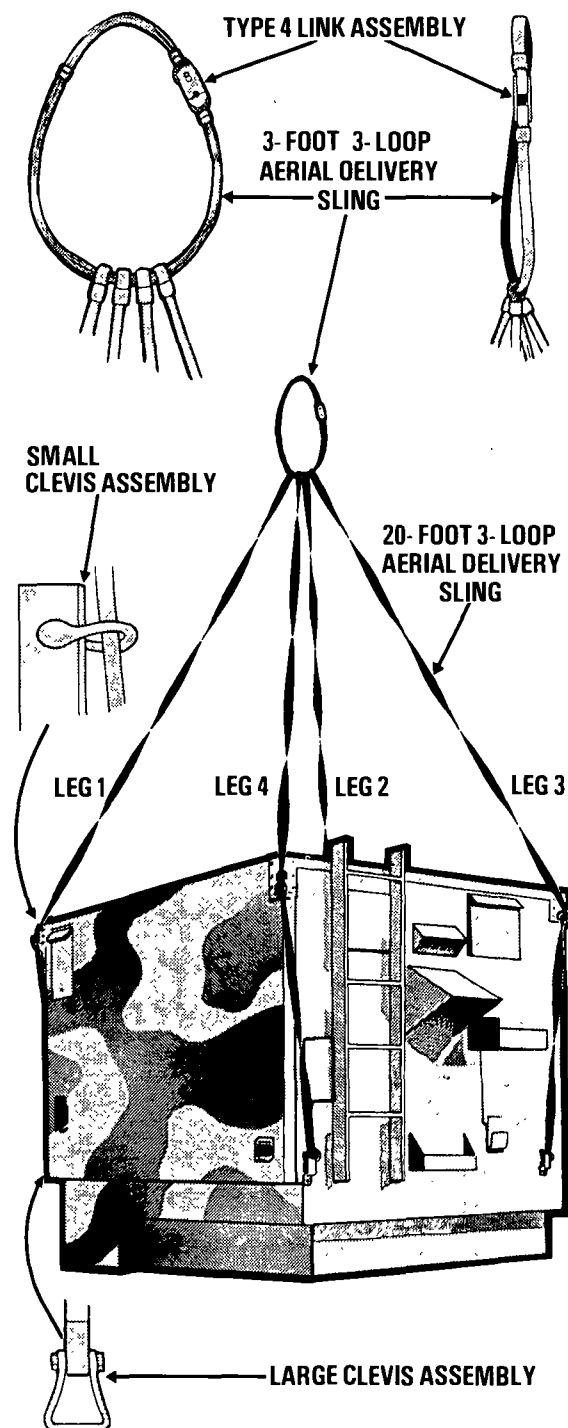


Figure 4-7. Rigging diagram for ground surveillance radar set AN/TPS-25A with electrical equipment shelter S-124/G.

15-foot tiedown straps with strap fasteners and load binders, one-half square yard of padding material, and 2-inch adhesive tape and 550-pound-capacity nylon as required.

Engage the parking brake.

Lower the tailgate to the horizontal position and tie it in place to prevent closing during flight.

Using one-fourth square yard of padding material for each bracket, pad the area above the rear tiedown brackets.

Secure all radar set components in spaces provided inside the shelter; bolt, tape, and tie down components as required.

Remove the ladder stowed on the outside of the shelter and tie it down inside the shelter.

Secure the gasoline and oil cans in the brackets on the rear of the shelter.

Close and lock the doors.

Fasten the intervehicular electrical cable, airhose, and safety chains to appropriate stowing brackets, and secure them with nylon cord.

Install four small clevis assemblies, one on each of the four top lifting brackets of the shelter.

With the strap fastener, attach one end of a 15-foot tiedown strap to each of the clevis assemblies at the top front corners of the shelter. Pass the free end of the 15-foot strap around the trailer drawbar and attach the load binder between the D-ring of the strap and the same clevis assembly at the top front of the shelter.

With the strap fastener, attach one end of a 15-foot tiedown strap to each of the clevis assemblies at the top rear corners of the shelter. Pass the free end of the 15-foot strap around the tailgate hinge bracket and attach the load binder between the D-ring of the strap and the same clevis assembly at the top rear of the shelter.

Place the 55-gallon drum of gasoline on the A-frame of the lunette and lash it down with nylon cord.

4-13. Rigging the Load *(see figure 4-8)*

Two men can rig the load in 10 minutes, using one 3-foot, 3-loop aerial delivery sling; four

9-foot, 3-loop aerial delivery slings; one 20-foot, 3-loop aerial delivery sling; two large clevis assemblies; three type IV link assemblies; and one 16- to 20-foot tag line. Using figure 4-8 as a guide, rig the load as follows:

Sling leg 1. Choke-hitch the 20-foot sling to the lunette by placing one end of the sling over the top of the neck and bringing the free end up through the eye of the lunette.

Sling leg 2. Attach the bell of a large clevis assembly to one end of a 9-foot sling. Attach the bolt of the clevis assembly to the *left* rear lifting bracket of the trailer. Pass the free end of the sling through the tailgate hinge space. With a link assembly, attach another 9-foot sling to the first 9-foot sling.

Sling leg 3. Attach the bell of a large clevis assembly to the *right* rear lifting bracket of the

trailer. Pass the free end of the sling through the tailgate hinge space. With a link assembly, attach another 9-foot sling to the first 9-foot sling.

Forming a ring. When attaching the legs to the 3-foot ring at the top, twist all legs so that there is one twist for every 3 feet of sling length; pass one end of the 3-foot sling through the upper ends of legs 3, 1, and 2, in that order; and connect the ends of the 3-foot sling with a link assembly.

Taping the legs. To prevent fouling of the slings before hookup, draw all three legs together at the top center of the load and wrap them with several turns of tape; approximately halfway between this strap and the ring, again wrap all three legs with several turns of tape.

CAUTION: Pad and tape the sling or load as necessary to prevent damage to the slings.

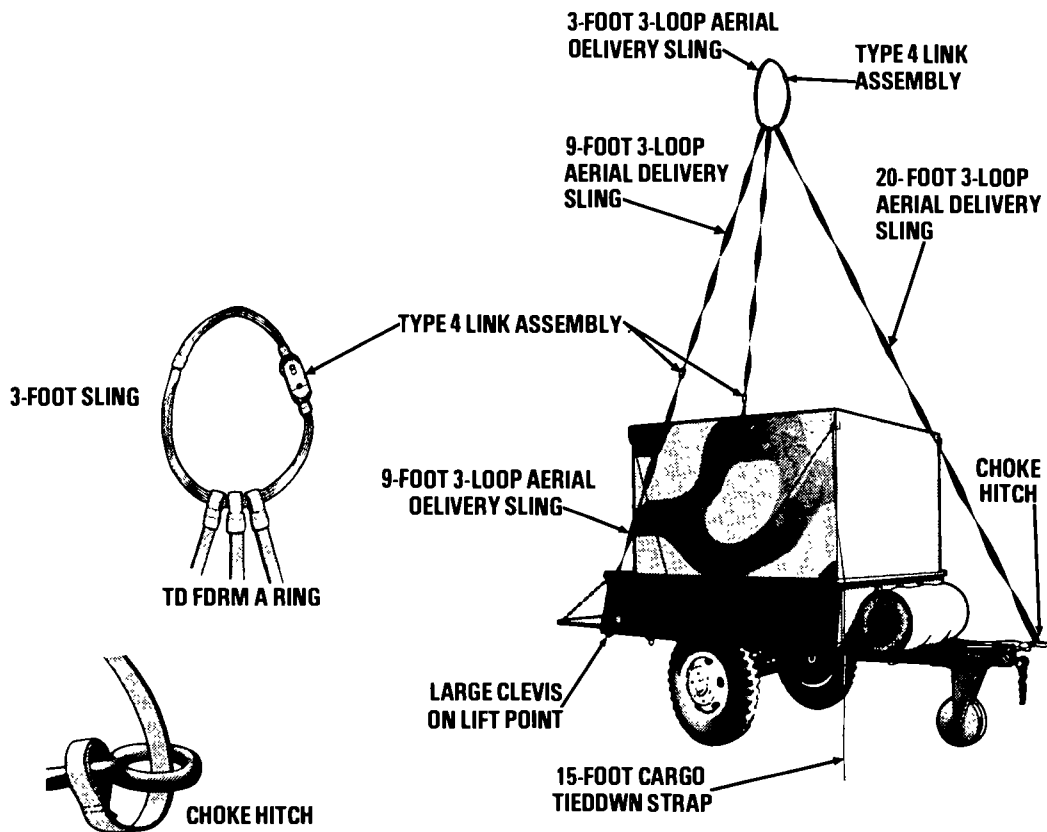


Figure 4-8. Rigging diagram for ground surveillance radar set AN/TPS-25 with electrical equipment shelter mounted on a 1½-ton cargo trailer.

CHAPTER 5

MOVING TARGET LOCATING RADAR SET AN/TPS-58

	Paragraph		Paragraph
Section I. Organization and Operation		Section II. Target Acquisition and Radar Gunnery	
Organization of Moving Target Locating Radar Section	5-1	Typical Mission Assignments	5-4
Duties of Personnel	5-2	Adjustment of Fire	5-5
Organization of Personnel for Operation	5-3	Center-of-Impact Registration	5-6

Section I. ORGANIZATION AND OPERATION

5-1. Organization of Moving Target Locating Radar Section

There is one AN/TPS-25 or AN/TPS-58 radar section in each target acquisition battery. The AN/TPS-58 has a six-man crew. Normally, the division artillery tactical operation center will site and control the operation of the radar. To reduce the radar's vulnerability (it is an active transmitter) and increase its effectiveness, the division artillery TOC will dictate when it is to radiate and the area it is to be oriented toward.

5-2. Duties of Personnel

The principal duties of key personnel in a moving target locating radar section

(AN/TPS-58) of a target acquisition battery are listed below.

Radar Technician

Advises commander and staff on equipment capabilities and employment. Performs reconnaissance to determine actual site. Coordinates the activities of all radar personnel in their respective duties.

Section Chief

Supervises the operation and operator maintenance of the radar equipment, assists the radar technician, and evaluates site after occupation of position.

Field Artillery Radar Mechanic

Performs organizational maintenance and repair of radar equipment and assists the radar technician.

Senior Field Artillery Radar Operator

Operates and supervises the operation of the radar set, assists in the emplacement and concealment of the radar, and assists the section chief in all his duties.

Radar Operator (Two)

Operates the radar, using the controls on the radar set control unit.

Operates and performs user maintenance on communication equipment utilized in the radar section.

Operates the radar's prime movers and performs scheduled maintenance on the prime movers. Provides local security and performs other duties assigned by the chief of section.

5-3. Organization of Personnel for Operation

A well-trained crew is essential to insure accurate and timely locations of enemy targets. Continuous operation may be required during combat; therefore, every man in the section must be capable of performing each of the duties necessary to acquire and process enemy targets.

For continuous operation, the section should be organized into two-man teams. To prevent fatigue, the team members should alternate the duties so that no one individual serves as control unit operator for more than 30 minutes at a time. When the teams are changed, the personnel on duty should be relieved one at a time. This will allow each person to become familiar with the situation as he assumes his duty.

Section II. TARGET ACQUISITION AND RADAR GUNNERY**5-4. Typical Mission Assignments**

Target acquisition is the primary mission of the AN/TPS-58. In this role, the operator will search the assigned sector of scan until a target is located. He will pinpoint and identify the target and provide the target location and description to the division artillery TOC, as prescribed by the local standing operating procedures (SOP). The operator will continue to track the target and be prepared to adjust artillery fire on it.

The radar may be used strictly for surveillance. In this role, the operator will perform the same functions as those above, with the exception of fire adjustment.

The radar may be used in a land navigation role to vector combat elements or reconnaissance patrols to predetermined areas in unfamiliar terrain or during hours of darkness or reduced visibility. When this mission is assigned to the radar section, close coordination between the radar operator and the combat element must be established by use of one or all

of the following means:

Communications by coded message.

Checkpoints and time schedules.

Prearranged signals that would be recognizable to the radar operator (e.g., swinging a helmet or metal object a specified number of times).

The AN/TPS-58 also may be used to track and vector aircraft. It has the capability to detect low-flying (less than 5,000 feet) fixed- and rotary-wing aircraft out to a distance of 20 kilometers. In MODE 4 operation, with the plotting board activated, the radar can accomplish limited aircraft vectoring and position prediction.

The radar may be used to survey the effects of indirect fires to detect evidence of any further enemy activity.

The radar may be used to survey areas for the presence of enemy air defense activity. The radar can easily detect the rotating antenna commonly used in conjunction with air defense radars and, subsequently, can plot the installation's location.

The azimuth and range marker of the AN/TPS-58 may be accurately positioned on any point to which electrical line of sight from the radar exists. Consequently, it may be used to register artillery fires even though the registration point is static. Range and azimuth from the radar to the registration point are computed and the antenna is positioned on this point by use of

the range and azimuth handwheels on the control indicator. Shellbursts are observed as shown in figure 5-1. The accuracy of the registration will be commensurate with the individual radar's capabilities and the operator's proficiency.

The site evaluation for the AN/TPS-58 is identical to the site evaluation for the AN/TPS-25 radar system.

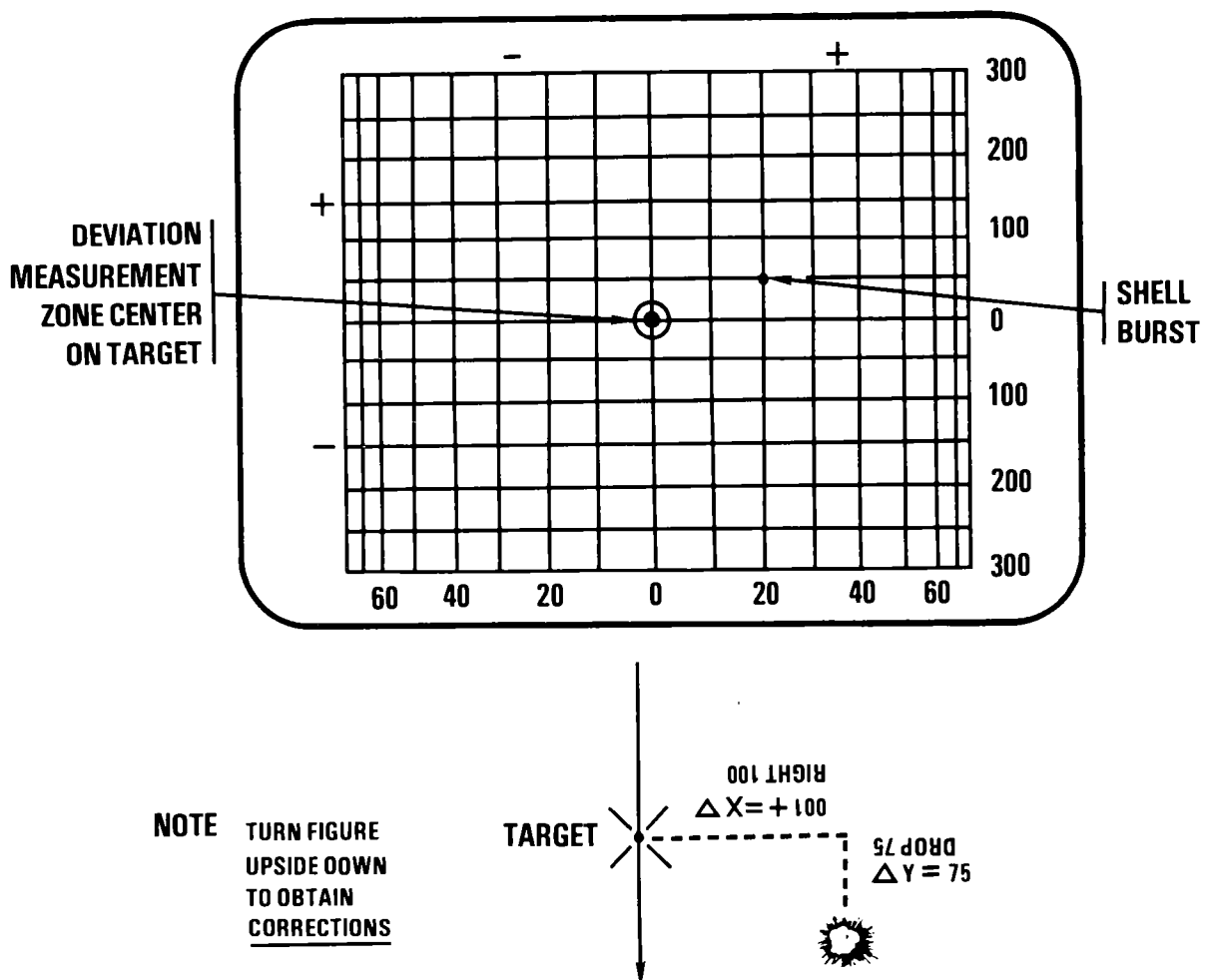


Figure 5-1. Center-of-impact registration form, AN/TPS-58.

5-5. Adjustment of Fire

Radar set AN/TPS-58 is capable of observing and locating bursts of artillery and mortar shells. This capability permits the use of the radar as the observer in the adjustment of artillery and mortar fire. The radar must have electrical line of sight to the target area. The maximum effective range varies in approximate proportion to the diameter of the projectile.

When the AN/TPS-58 is used to adjust artillery or mortar fire, the arbitrary DIRECTIONS 3200 will be included in the call for fire to facilitate direct reading of the corrections from the counters of the digital display unit. Deviations in easting and northing from the target to the burst are determined from the ΔX and ΔY counters on the digital display unit. Easting deviations are converted to lateral shifts, and northing deviations are converted to range shifts as shown in figure 5-2.

5-6. Center-of-Impact Registration

General

A radar-observed center-of-impact registration conducted with the AN/TPS-58 radar set is a registration mission conducted with the radar set as the observer. The information required by the FDC is the "did hit" location of the impact point so that FDC can adjust their firing charts to insure first-round target hits in future missions.

However, where the AN/MPQ-4A conducted the mean-point-of-impact registrations on a selected datum plane as the rounds passed through the radar beam, the AN/TPS-58 will conduct the mission on the ground at the actual point the rounds impact.

Sequence of Events

The sequence is outlined on the center-of-impact registration form in figure 5-2.

Step one—The receipt of the message to

RADAR-OBSERVED CENTER-OF-IMPACT REGISTRATION (AN/TPS 58)																	
STEP ONE: Message to Observer					STEP TWO: Radar Pointing		STEP THREE: Report to FDC										
1 Observer	CI	5 Pointing Azimuth	1493-32 = 1461			AT MY COMMAND REQUEST SPLASH (ready to observe)											
2 FDR (Unit or Call Sign)		6 Pointing Range	6720-110 = 6610														
3 AT GFID	4800 38000 4838 27910 67920	7 Registration Point Alt	381														
3a Recentered Grid	47910 37920	8 Radar Altitude	361														
4 REPORT WHEN READY TO OBSERVE		9 Vertical Interval (17 ft)	20														
		10 Elevation Angle (15 + 6)	+3														
STEP FOUR: Recording and Computations																	
Deviation Scope Data					L Box Data												
ROUND	AZIMUTH		RANGE		ΔX		ΔY										
	left -	right +	short -	over +	- ΔX	+ ΔX	- ΔY	+ ΔY									
1	320		1100		900		900										
If required adjust pointing data and correct blocks 3,5,6																	
<table border="1"> <tr> <td>11</td> <td>12</td> <td>13</td> <td>14</td> </tr> <tr> <td>15 Azimuth Corr 8 320 -9 111</td> <td>16 Range Corr 6 1100 -10 112</td> <td>17 ΔX Corr 6 900 0 113</td> <td>18 ΔY Corr 6 900 -10 114</td> </tr> </table>										11	12	13	14	15 Azimuth Corr 8 320 -9 111	16 Range Corr 6 1100 -10 112	17 ΔX Corr 6 900 0 113	18 ΔY Corr 6 900 -10 114
11	12	13	14														
15 Azimuth Corr 8 320 -9 111	16 Range Corr 6 1100 -10 112	17 ΔX Corr 6 900 0 113	18 ΔY Corr 6 900 -10 114														
STEP FIVE: Coordinate Computation					STEP SIX: Report to FDC												
19 Registration Point Coordinates (lat)					28 Report on radar observed CENTER OF IMPACT												
47910 37920					27 Pointing Range (ft)												
					6310												
					23 Range Correction (ft)												
					-10												
20 ΔX and ΔY Corrections (17 ft)					24 Range (Radar to Burst) (22 + 23)												
$\Delta X = 0 \quad \Delta Y = -10$					6600												
					25 Pointing Azimuth (ft)												
					1461												
21 DID HIT Coordinates (15 20)					26 Azimuth Correction (ft)												
47910 37910					-9												
					27 Azimuth (Radar to Burst) (25 + 26)												
					1452												
					22 Coordinates (17 or 28)												
					47910 37910												

observer sent by the FDC to observe a center-of-impact registration mission.

Step two—The computation of the pointing data required by the radar set to observe the mission.

Step three—The report to FDC that the radar is ready to conduct the mission and that firing will be at radar's command, requesting SPLASH on each round.

Note. The transmitter will be fired only after FDC has given the 10-second SPLASH warning. After the round is marked, the transmitter will be turned off and the round strobed.

Step four—The observation of the impact and the recording of the data for each round.

Step five—The computation of did hit coordinates based on the average of the six rounds fired.

Step six—The report to FDC of the data obtained of the impact.

RADAR-OBSERVED CENTER-OF-IMPACT REGISTRATION (AN/TPS 58)					For use of this form, see FM 6-161, the proponent agency is US Army Training and Doctrine Command.			
STEP ONE: Message to Observer			STEP TWO: Radar Pointing			STEP THREE: Report to FDC		
1. Observe CI			5. Pointing Azimuth 1493-32=1461			AT MY COMMAND REQUEST SPLASH (ready to observe)		
2. FDR (Unit or Call Sign)			6. Pointing Range 6420-110=6310					
3. AT GRID 48000 38000 4838 48918 37920			7. Registration Point Alt 381					
3a. Reoriented Grid 4791037920			8. Radar Altitude 361					
4. REPORT WHEN READY TO OBSERVE			9. Vertical Interval (7-8) 20					
			10. Elevation Angle (9 - 6) +3					
STEP FOUR: Recording and Computations								
ROUND	Deviation Scope Data				L-Box Data			
	AZIMUTH		RANGE		ΔX		ΔY	
	left -	right +	short -	over +	- ΔX	+ ΔX	- ΔY	+ ΔY
1.	32	0	110	0	90	0	80	0
If required adjust pointing data and correct blocks 3,5,6.								
2.	5		30		30		40	
3.	10			20	20			30
4.	15		10		10		30	
5.	12		20		10		20	
6.	14		0		10		0	
7.		10	60			50	60	
Total	-52	+0	-60	+20	-80	+50	-90	+30
Alg total	11	-52	12	-40	13	-30	14	-60
	15 Azimuth Corr (-9) 8.6 6 $\overline{52}$ (11) 48 40 (Nearest 10)		16 Range Corr (-10) 6 6 $\overline{40}$ (12) 36 40 (Nearest 10m)		17 ΔX Corr (0) 5 6 $\overline{30}$ (13) (Nearest 10m)		18 ΔY Corr (-10) 10 6 $\overline{60}$ (14) (Nearest 10m)	
STEP FIVE: Coordinate Computation					STEP SIX: Report to FDC			
19. Registration Point Coordinates (3a) 47910 37920			Alternate Coordinate Computation Method			29 Report on radar observed CENTER OF IMPACT		
20. ΔX and ΔY Corrections (17 & 18) ΔX 0 ΔY -10			22. Pointing Range (6) 6310			30. Time Observed 0306 1600		
			23. Range Correction (16) -10			31. Altitude (DID HIT) 365		
21. DID HIT Coordinates (19-20) 47910 37910			24. Range (Radar to Burst) (22 + 23) 6300			32. Coordinates (21 or 28) 47910 37910		
			25. Pointing Azimuth (5) 1461					
			26. Azimuth Correction (15) 1452					
			27. Azimuth (Radar to Burst) (25 + 26)					
			28. L-Box Coordinates 47910 37920					

DA FORM 4705-R (1 Jun 78)

Figure 5-2. Determination of lateral and range corrections.

Personnel Requirements

Two personnel are required to perform the radar-observed center-of-impact registration with the AN/TPS-58.

The radar operator observes the rounds on the radar set control unit.

The recorder/radiotelephone operator controls the mission and records the data.

Conduct of the Mission

The first step in the mission is the receipt of the message to observer by the radar section. This is a standard artillery message and contains the following elements:

Warning order. Consists of the phrase OBSERVE CENTER OF IMPACT. This informs the radar section of the type of registration to be fired and alerts them to begin preparation for the mission.

Unit to fire. Consists of FOR followed by the call sign of the unit that will be firing. This element may be omitted if it is not necessary for the radar section to contact the firing unit.

Grid. This specifies the grid location of the registration point. It consists of the words AT GRID followed by the grid location of the registration point. If reorientation is required, the corrected registration point grid will be inserted here.

Report order. Consists of the phrase REPORT WHEN READY TO OBSERVE. This reminds the radar section to report back to the FDC when they have completed their preparations and are ready to observe.

The second step is computation of the pointing data to be used by the radar to observe the mission.

● When the radar set itself is used to compute the pointing data, the set must be operated in MODE 3 as follows:

Place the OPERATE switch on the L-box to the SET AZ position, place the ALIGN DISPLAY switch on the L-box to the X₁Y₁ position, and use the X₁Y₁ handwheels on the L-box to insert the registration point coordinates into the X and Y counters.

Place the ALIGN DISPLAY switch to SET 0; and using the azimuth handwheel and the

*Note: DA Form 4705-R may be locally reproduced using the form located on page A-5.

STEP ONE: Message to Observer	
1. Observe	CI
2. FOR (Unit or Call Sign)	
3. AT GRID	$\begin{array}{r} 48000 \quad 38000 \\ -90 \quad -80 \\ \hline 4838 \quad 47920 \end{array}$
3a. Reoriented Grid	4791037920
4. REPORT WHEN READY TO OBSERVE	

STEP TWO: Radar Pointing	
5. Pointing Azimuth	1493-32 = 1461
6. Pointing Range	6420-110 = 6310
7. Registration Point Alt	381
8. Radar Altitude	361
9. Vertical Interval (7-8)	20
10. Elevation Angle (9 ÷ 6)	+3

three lights on the bottom of the L-box, rotate the handwheel in the direction of the outside lamp until the center lamp illuminates. This will orient the radar in azimuth to the grid of the registration point.

Set the *OPERATE* switch on the L-box to the *OPERATE* position and rotate the range handwheel until the coordinates of the registration point are displayed on the X and Y counters.

The pointing data for the radar set may now be read directly from the range and azimuth dials.

Elevation pointing data are computed on the form; the use of a map of the area and the altitude of the radar is required.

Once the radar section has computed the pointing data and oriented the radar set on the registration point, they are ready to observe the mission.

The third step is the report to FDC. This informs the FDC that the radar section is prepared to observe the mission. The message also tells FDC that the rounds will be fired at radar's command, that *SPLASH* is requested, and that the radar is ready to observe.

The fourth step in the mission is the observation of the rounds as they impact and the recording of the deviation of the impacts from the registration point. Deviations may be recorded either in range and azimuth or in ΔX and ΔY . Deviations are measured by the radar operator observing the round bursts on the deviation scope and marking the point with a white grease pencil. Range and azimuth deviation will be measured from the grid on the face of the deviation scope, by placing the false target at the point where the round burst, and by reading the X and Y counters with the display switch in ΔX & ΔY position.

The deviations measured in this step are recorded in STEP FOUR of the form. If the first round bursts over 30 mils or 150 meters from the center of the deviation scope, the radar will be reoriented and the round treated as a usable round with a 0-0 deviation. If the radar set is reoriented, the corrections must be applied to blocks 3a, 5, 6, and 7 on the form where the grid and the pointing data are recorded. Any future

STEP THREE: Report to FDC

AT MY COMMAND REQUEST
SPLASH

(ready to observe)

STEP FOUR: Recording and Computations									
ROUND	Deviation Scope Data				C Box Data				
	AZIMUTH		RANGE		ΔX		ΔY		
	left -	right +	short -	over +	- ΔX	+ ΔX	- ΔY	+ ΔY	
1	32	0	110	0	90	0	80	0	
If required adjust pointing data and correct blocks 3, 5, 6									
2	5		30		30		40		
3	10			20	20				30
4	15		10		10		30		
5	12		20		10		20		
6	14		0		10		0		
7		10	60			50	60		
Total	-52	+0	-60	+20	-80	+50	-90	+30	
Alg. total	11		12		13		14		
15 Azimuth Corr. (-9)		16 Range Corr. (-10)		17 ΔX Corr. (0)		18 ΔY Corr. (-10)			
6 52 +40 ----- 112 (111) (Nearest 10)		6 40 +30 ----- 70 (70) (Nearest 10m)		6 5 +5 ----- 10 (10) (Nearest 10m)		6 10 +50 ----- 60 (60) (Nearest 10m)			

round will be considered valid if it bursts within 30 mils of the center of the deviation scope in azimuth and 100 meters of the center of the deviation scope in range.

After valid data for six rounds are obtained, announce END OF MISSION to FDC. Then compute the deviations for the mission by averaging the individual deviations recorded. Apply the average deviations in ΔX and ΔY to the grid of the registration point or the average deviation in range and azimuth to the pointing range and azimuth.

- If the ΔX and ΔY deviations are used, no further computations are required, since the did hit grid is now available.

- An alternate method, if the range and azimuth deviations are used, is to compute the did hit grid by entering the range and azimuth into the radar set and reading the grid on the L-box. The range and azimuth are polar-plotted from the radar to the did hit grid, and the grid is read on the firing chart.

When the did hit grid is available, the information is entered in STEP SIX on the registration form and the final report of the mission is sent to FDC following the format in STEP SIX of the form.

STEP FIVE: Coordinate Computation	
19. Registration Point Coordinates (3a)	Alternate Coordinate Computation Method
47910 37920	22. Pointing Range (6) 6310
	23. Range Correction (16) -10
20. ΔX and ΔY Corrections (17 & 18) ΔX 0 ΔY -10	24. Range (Redel to Burst) (22 + 23) 6300
	25. Pointing Azimuth (5) 1461
	26. Azimuth Correction (15) -9
21. DID HIT Coordinates (19-20)	27. Azimuth (Redel to Burst) (25 + 26) 1452
47910 37910	28. L Box Coordinates 479003792

STEP SIX: Report to FDC
29. Report on radar observed CENTER OF IMPACT
30. Time Observed 0306 1600
31. Altitude (DID HIT) 365 365
32. Coordinates (21 or 28) 47910 37910

★ CHAPTER 6

FIREFINDER MORTAR LOCATING RADAR SET AN/TPQ-36

Section I. Organization

	Paragraph		Paragraph
Organization of the AN/TPQ-36		Tactical Considerations	6-6
Radar Section	6-1	Technical Considerations	6-7
Duties of Personnel	6-2	Safety	6-8
Organization of Personnel		Administrative and	
for Operation	6-3	Logistical Support	6-9
		Camouflage	6-10
		Shelter Operations	6-11
		Hostile Weapons Location	
		Operating Procedures	6-12
		Friendly Fire Mode	
		Operations	6-13
Section II. Tactical Employment and			
Position Requirements			
Tactical Mission	6-4		
Selection of Site	6-5		

The mortar locating radar AN/TPQ-36 detects and locates enemy mortars, short-range artillery, and rockets quickly and accurately enough for immediate engagement by friendly counterfire. The AN/TPQ-36 is a phased-array radar system. It uses a combination of radar techniques and computer-controlled signal processing to detect, verify, and track the projectiles in flight. The tracking data are used to determine the projectile's trajectory, which can be

extrapolated to give either the weapon location or the projected impact point. The radar operator can command the data to be formatted and digitally transmitted to the supported artillery fire direction center (FDC), stored by the radar's computer, or deleted as the situation dictates. The automated signal processing and electronic beam steering allow the radar to continue to search for new targets while tracking the targets already detected. Thus, the system can detect and locate

weapons firing simultaneously from multiple positions. The radar can also be used to register and adjust friendly indirect fire.

The AN/TPQ-36 is highly mobile and can be deployed in forward combat zones. All mission-essential elements can be transported by standard military vehicles, medium-lift helicopters, and C-130 type aircraft. The system can be emplaced and ready for operation within 15 minutes (30 minutes when airlanded) and displaced within 5 minutes. The AN/TPQ-36 hardware and software are optimized to locate short-range and high-angle weapons at ranges from 0.75 to 24 km and to complement the longer range artillery locating radar AN/TPQ-37 and/or other target acquisition sensors.

The AN/TPQ-36 radar system consists of an operational control group and an antenna-transceiver group trailer. The operational control group is housed in a standard S-250 shelter. The shelter provides space for radar operation and for the data processing, display, and communications equipment. The antenna-transceiver trailer carries the 10-kw, 400-Hz turbine generator; the planar-array antenna; the transmitter; the receiver; and associated electronics. For concealment and protection, the shelter can be located up to 50 meters from the trailer during operations. The antenna can search a 1,600-mil azimuth sector. When required, the system can provide 6,400-mil sector coverage by automatically searching one sector for a defined period; detecting, tracking, and locating targets in the sector; and then mechanically turning to the next sector.

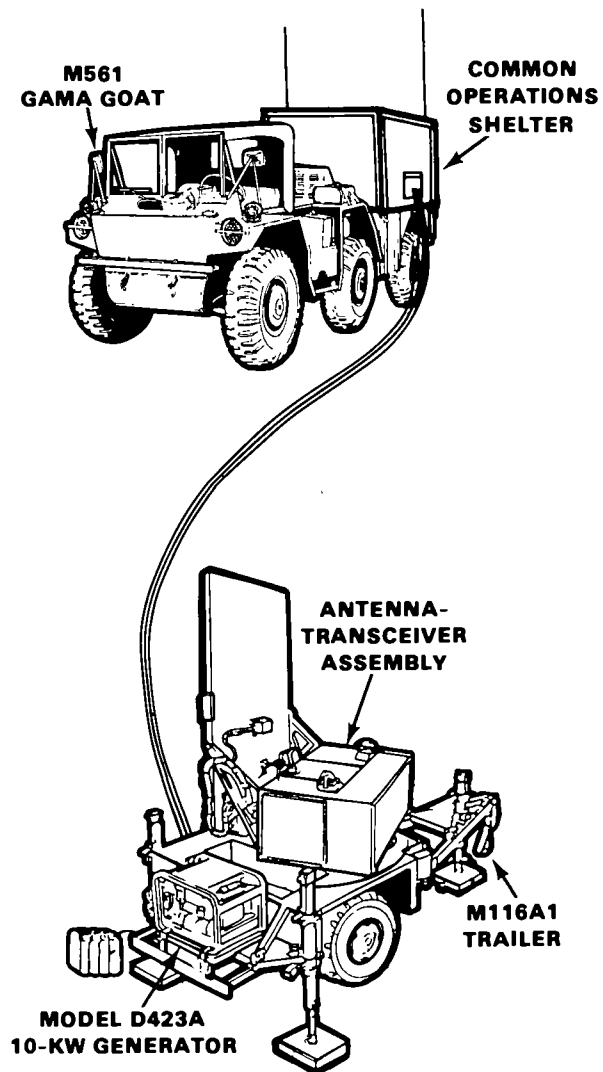


Figure 6-1. AN/TPQ-36 radar system.

Section I. ORGANIZATION

6-1. Organization of the AN/TPQ-36 Radar Section

There are three AN/TPQ-36 radar sets in each target acquisition battery (TAB). All AN/TPQ-36 radars are allocated by the division

artillery (div arty) S3 across the division front. Allocation is based on command guidance, the terrain, and the enemy situation. The radars usually are attached to the direct support (DS) field artillery battalions to insure immediate, responsive target acquisition. The using artillery battalion designates the general position area.

The radar warrant officer or section chief selects the actual site. Additional sites are selected so an alternate position is always available. The div arty tactical operations center (TOC) (assistant TOC team chief) furnishes the SOP on the frequency and length of emissions for the radar transmitter. Radar position areas usually are in the vicinity of an artillery unit, 3 to 6 km from the forward edge of the battle area (FEBA). Section personnel and equipment are as follows:

Personnel

TITLE	GRADE	MOS	QUANTITY
Radar technician	WO	211A	1
Section chief	E6	13R30	1
Senior radar operator	E5	13R20	1
Radar operator	E3/E4	13R10	4
Radar mechanic	E4	13R10X5	1

Equipment

EQUIPMENT	QUANTITY	BTRY TOTAL
1¼-ton truck with S-250 shelter (M561)	1	3
1¼-ton truck with ¾-ton trailer (M561)	1	3
Antenna trailer (modified M116A1)	1	3
1¼-ton cargo vehicle (M884)	1	3

6-2. Duties of Personnel

The principal duties of key personnel in the AN/TPQ-36 radar section of a TAB are listed below.

Radar Technician

Advises commander and staff on equipment capabilities and use. Reconnoiters to determine actual radar site. Supervises the activities of all radar personnel in their duties.

Section Chief

Supervises operator maintenance and operation of the radar equipment. Assists the radar technician. Evaluates radar site after occupation of position.

Senior Radar Operator

Operates or supervises the operation of the radar set. Assists in the emplacement of the radar and concealment of the position. Assists the section chief in all of his duties.

Radar Operator

Operates the radar and ancillary equipment. Determines and corrects the altitudes of the weapon locations from a contour map. Transmits the final locations to a controlling headquarters. Keeps the necessary records. Operates and performs maintenance on section vehicles. Provides local security. Operates, and performs user maintenance on, section communication equipment. Operates, and

performs operator and organizational maintenance on, the power generator. Performs other duties assigned by the chief of the section.

Radar Mechanic

Performs organizational maintenance on the radar and generator. Operates radar as required. Assists the radar technician.

6-3. Organization of Personnel for Operation

A well-trained radar crew is essential for accurate, timely locations of hostile weapons. Continuous operation may be required during combat. Therefore, each man in the section must be able to perform every duty necessary to obtain and process hostile weapon locations.

For continuous operation, the section should be organized into three two-man teams. These teams exclude the radar technician and the radar mechanic, who are on call continuously. These two-man teams consist of a radar operator and an assistant, who also maintains the generator.

Section II. TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

6-4. Tactical Mission

The AN/TPQ-36 is composed of the antenna-transceiver trailer and the operations control shelter. The system is designed primarily to locate high-angle mortar, rocket, and cannon artillery firing positions. With its automatic detection, tracking, and locating process, it can consistently locate weapons firing simultaneously from multiple positions. Also, the radar can adjust friendly fire and provide registration.

The following affect the mission assigned the AN/TPQ-36 radar section:

Mission of the supported unit.

Tactics and employment techniques of the enemy artillery.

Amount and type of weapons in the enemy force and the degree to which they are active.

Capabilities and limitations of the AN/TPQ-36 radar and other target acquisition systems.

Enemy electronic countermeasures capabilities.

After considering all factors, the commander assigns a primary mission and sector(s) of search.

6-5. Selection of Site

The targeting element of the div arty TOC, under the supervision of the div arty S3, provides the radar section guidance on coordination of search areas, frequency, and length of mission.

When a radar section is attached to a field artillery unit, the positioning authority for that unit selects and coordinates position areas for the radar section. When not attached to a battalion, the TAB commander, acting as a special staff officer, advises and assists the assistant S3 for plans on the selection of position areas for elements held under div arty control. This general position area should be large enough that the radar technician or section chief may select the actual radar site based on the technical and tactical considerations affecting the operation of the radar.

If possible, the radar position should be near a field artillery unit. This would facilitate communications, survey, and logistics and take advantage of any existing defensive perimeter. The benefits of such positioning must be weighed against the hazards associated with the enemy's EW capability. Detection and location of the radar by enemy radar direction-finding equipment could reveal the location of the adjacent unit.

The radar technician or chief of section reconnoiters the general position area before selecting the actual radar site. If time permits, this reconnaissance is divided into two phases—a map reconnaissance and a ground reconnaissance.

Map Reconnaissance

The map reconnaissance is made to determine, but is not limited to, the following:

- Possible sites available
- Routes into and out of the area
- Identifying landmarks
- Locations of adjacent units

Ground Reconnaissance

A ground reconnaissance is made after the map reconnaissance to aid in occupation of the selected position. The ground reconnaissance is

based on the tactical and technical considerations for the radar as modified by the particular mission, situation, and terrain. The time available for reconnaissance is generally limited. Therefore, the reconnaissance must be organized so it can be as complete as possible in the time allotted. It must be detailed enough that the radar technician or chief of section can make decisions and issue orders concerning:

- Exact location of the radar
- Location of the radar operations center
- Location of the truck park
- Routes into and out of the area
- Searching and marking the area for mines
- Local security, to include camouflage and defense against air and ground attack
- Selection of alternate positions
- Measurement of site screening crest

6-6. Tactical Considerations

The tactical considerations in selecting a radar site are similar to those in choosing a position for a field artillery firing battery. Normally, they include communications, concealment, cover, routes of approach, security, and survey.

Communications

The system requires three AN/VRC-46 radios, wire, three TA-312/PT, and a radio set control group AN/GRA-39. Other communication needed is limited to telephones for administrative use and radios in site reconnaissance vehicles for the advance party.

The AN/TPQ-36 section operates in an operations/F net (digital) and a command net as directed by the controlling headquarters. Usually, these two nets belong to the supported DS battalion. Depending on task organization, the nets may be a digital net to the div arty TOC and a voice net to the TAB.

The radar section maintains a digital interface with the supported TACFIRE (tactical fire direction system). The preferred link is land line. If land line is not practical, the link will be the appropriate FM net. TACFIRE address and authentication identification codes are per current CEOI.

Concealment

The radar site must take advantage of natural concealment, such as trees and shrubs.

Cover

The radar should be emplaced in defilade to the enemy to give personnel and equipment all possible protection from hostile fire.

Routes of Approach

The site should have more than one route of approach to allow occupation without observation. Road conditions, overhead clearances, bridges, and stream fords must be considered.

Physical Security

If possible, the radar site should be within the defensive perimeter of another unit. This will ease the local security requirements for the radar system.

Survey

The exact radar position area must be reported to the controlling headquarters survey officer.

The required survey data and site information are provided by the survey section. A fifth-order survey is required to determine the site grid coordinates. A visible boresight reference point a minimum of 100 meters in any direction from the primary point must be established and marked to properly orient the antenna. The radar survey requirements are:

Site location (UTM easting and northing coordinates)

Site altitude

Distance from the primary site to the boresight reference point

Azimuth from the primary site to the boresight reference point

Vertical angle from the primary site to the boresight reference point

Survey data must be entered into the system during initialization. Remember that survey accuracy affects the accuracy of weapon locations.

If survey data are not available when the radar arrives at the site, the radar section performs a hasty survey and map inspection. These procedures are outlined in TM 11-5840-354-10-1, *Operators Manual for Mortar Locating Radar AN/TPQ-36*, chapter 2, section II. These data will be used until survey arrives.

Note. Usually, meteorological data are received in the radar shelter on a scheduled basis over one of the AN/VRC-46 radios. The radar uses standard met until current data become available.

6-7. Technical Considerations

A screening crest is not essential in locating hostile weapons with intercept-type radars, like the AN/TPQ-36. However, it does increase the survivability of the system. The area between the radar and the screening crest will be obscured by clutter and cannot be used for detection of weapons. Therefore, if the radar is emplaced behind a screening crest, the crest should be in friendly territory and within 1,000 meters of the radar. It is desirable that the AN/TPQ-36 radar scan at an elevation of 45 mils or less. When the automatic terrain-following (ATF) feature is used, the beam is 15 mils above the screening crest. Therefore, the vertical angle to the screening crest should not exceed 30 mils. A screening crest is also useful as a defense against electronic warfare.

Other technical considerations in selecting the radar site are:

Maximum range of the radar is 15,000 meters for mortars and artillery and 24,000 meters for short-range rockets.

Sector coverage is 1,600 mils. Sector scan of 6,400 mils may be used (1,600-mil segments).

6-8. Safety

In addition to common sense and safety procedures associated with the operation of military equipment, the following specific precautions apply to the AN/TPQ-36.

Warning

See warning page of TM 11-5840-354-10-1.

Projections

Projections from the antenna-transceiver group (trailer) are hazardous to personnel walking around the unit.

Microwave Radiation

Personnel can be exposed to microwave radiation when the transmitter is energized. Personnel in the vicinity of the antenna should insure that the XMTR power switch on the transmitter power distribution panel is in the OFF position so that personnel inside the shelter cannot accidentally operate the transmitter. If personnel must be in the vicinity of the antenna during transmitter operation, they should remain behind the antenna face.

Electronic radiation is dangerous. The hazard extends 107 meters in front of the antenna when it is in the 1,600-mil sector of scan. Radiation hazard signs will be placed a minimum of 107 meters in front of the antenna sector of scan.

Antenna Rotation

Personnel standing or working on the antenna can be injured if the antenna is rotated. They should insure that the antenna drive circuit breaker switch on the trailer power distribution panel is in the OFF position so that personnel inside the shelter cannot accidentally drive the antenna.

Generator

High-temperature areas on the generator set can result in burns. Therefore, personnel should not touch any part of the generator set except the control panel.

Hearing protection is required for personnel working within 2 meters of the generator set while it is operating.

Power Entrance Panels

Improper matching of connectors with receptacles can lead to pin damage, possibly resulting in a short. Therefore, connectors, receptacle keying, and orientation should be verified before cable connection. Cable connectors should never be forced into receptacles with mismatched keying.

Transit

A sudden stop or an accident in transit could result in damage to equipment or injury to personnel. Therefore, operating personnel will not ride either in the shelter van or on the antenna trailer. Also, all equipment panels, drawers, loose equipment, etc., must be secured before transit.

Electrical Shock

Electrical shock can cause breathing to cease. A casualty may recover if cardiopulmonary resuscitation is given promptly and efficiently. The principles and procedures for treatment for electrical shock are in FM 21-11, *First Aid for Soldiers*. All personnel should be made aware of the location of high-voltage junctions.

Maintenance

Using personnel will not maintain or inspect the radar equipment beyond those functions authorized in the appropriate technical manual.

High Wind

When the wind velocity is 52 mph or higher or gusts up to 75 mph, the antenna must be placed in the stow position.

6-9. Administrative and Logistical Support

During garrison operations, the TAB provides all administrative/logistical support for the Firefinder radar section. However, when attached to field artillery units, individual radar sections will receive such support for the more common areas of personnel services, mess, maintenance, and POL (petroleum, oil and lubricants) from the gaining unit unless otherwise specified in the attachment order.

Personnel Services

Personnel and administration support for routine actions is provided by the supported FA unit. For nonroutine actions, individual section members must be transported back to the TAB headquarters. Nonroutine actions include Uniform Code of Military Justice (UCMJ) actions, promotions, transfers, and requests for discharge.

Mail, pay, and routine distribution are consolidated by the parent unit (TAB) and forwarded by courier on a regular basis to the supported FA unit headquarters. The supported FA unit makes distribution to the radar section during normal operational runs to its subordinate batteries.

Mess

The supported FA unit supports the attached radar section in conjunction with normal operations.

Maintenance

The supported FA unit performs automotive and radio repair. Those items of equipment that must be evacuated for higher level maintenance are recovered to the parent TAB if time permits. If this is not practical, the parent TAB is informed of action taken and of the need to replace the evacuated item. The Firefinder maintenance plan uses four levels of support: organizational, direct, general, and depot.

ORGANIZATIONAL MAINTENANCE. Ninety percent of all failures are detected and corrected at this level. Each radar section has an

organizational mechanic (MOSC 13R10 with X5 additional skill identifier (ASI)) to perform on-site maintenance. Duties include replacing malfunctioning assemblies, subassemblies, modules, and cards which are isolated by using built-in test equipment (BITE) and performing adjustments using a multimeter. Space and weight constraints limit running spares to selected modules and tools. Test equipment is limited to a Firefinder-peculiar tool kit and a multimeter. Organizational maintenance personnel use the running spares to restore the system to operation. Organizational maintenance is divided into two categories:

- **Operator maintenance tasks.** The operator monitors equipment and performs noncritical adjustments and preventive maintenance. He also performs selected repair functions, such as replacement of defective fuses, lamps, and bolts.
- **Organizational maintenance tasks.** Organizational maintenance for the radar set includes:

Performing preventive maintenance to include visual inspection, test, cleaning, tightening/adjusting, and other minor adjustments.

Making external adjustments on equipment and performing operational checks and adjustments using appropriate tools and test equipment.

Making continuity and operational checks on external interconnecting cable assemblies and performing minor cable and cable connector repair.

Analyzing the causes of equipment malfunction to the defective module (item, component, assembly, subassembly, printed/wired circuit board or card) using easy to interpret, built-in test isolation equipment. The mechanic is limited to replacement modules that are easy to remove/install and are authorized by the maintenance allocation chart (MAC). Included are those items that do not require complex or critical adjustments or system alignment after replacement. Unserviceable modules are evacuated for DS repair as prescribed by the MAC.

The AN/TPQ-36 power generator (D423) is operated by Firefinder radar operators and maintained at organizational level by the Firefinder radar mechanic.

At organizational level, the mean time to repair the radar is 30 minutes and the maximum time is 2 hours.

DIRECT SUPPORT MAINTENANCE.

Requests for direct support are originated by the organizational mechanic with the concurrence of the radar technician. The requests go through the controlling unit headquarters (for attached radars) or through the TAB headquarters (for general support (GS) radars). Requests are processed by the fastest means consistent with security considerations to the appropriate DS maintenance battalion. The TAB commander is advised of all such requests to insure that support response is in keeping with the commander's counterfire priorities. The information required is:

- Unit and equipment administration number.
- Equipment location.
- Point of contact at location.
- Method of establishing direct communications with point of contact.
 - As complete and correct as possible diagnosis of the nature and location of the problem and/or possible corrective action.

The headquarters and light maintenance company provides Firefinder DS maintenance. The weapons support radar repairer (MOSC 26B20 with K1 ASI) is a member of the electronic maintenance section. He performs selected tests and repairs/replaces components in a van-mounted repair facility. He has a complete set of tools, test equipment, and repair parts at his disposal. This facility is in the division support area, and usually a radar must be evacuated to that location for major repair. As necessary, he may join the TACFIRE maintenance support team of the heavy maintenance company or be transported by radar section or TAB personnel to perform on-site maintenance.

DS maintenance for the Q-36 generator is provided by the power generation equipment repairmen (MOS 52D) assigned to the generator

equipment maintenance sections of the three forward support companies. The TAB must coordinate this support with each forward support company.

At DS level, the mean time to repair the radar is 2 hours. Maximum time is 4 hours with two persons, one of which must be a 26B20K1.

GENERAL SUPPORT MAINTENANCE. GS maintenance of Firefinder-peculiar items is limited to repair of printed circuit boards by the electronic repair facility using automatic test equipment. The facility repairs unserviceable items and returns them to stock or evacuates them to the repair facility designated in the MAC. There are 81 reparable printed circuit boards in the Firefinder systems. Seventeen are peculiar to the Q-37 and eight are peculiar to the Q-36.

GS maintenance for Firefinder associated support equipment is performed by the responsible elements of the corps GS maintenance battalion.

DEPOT MAINTENANCE. Depot maintenance can completely overhaul and recondition the major end items and assemblies that are beyond the capabilities of field maintenance units. Sacramento Army Depot is designated for Firefinder.

Military Occupational Specialties (MOS)

THE FIREFINDER ORGANIZATIONAL MECHANIC (MOSC 13R10X5)—

- Operates Firefinder radar and associated equipment.
- Performs organizational maintenance on Firefinder radars.
- Assists in emplacement and march order.
- Tests the operation and evaluates the status of the radar.
- Performs inspection, preventive maintenance, and servicing to establish and maintain the radar in an acceptable operation condition.
- Performs adjustments. Uses built-in tests to detect system malfunctions and isolates them to the defective module, printed circuit board, chassis, cable, or component. Uses external test equipment as required.

- Restores equipment to operation by removing and replacing the defective item as authorized by MAC.
- Maintains work logs and prepares supply requisitions.
- Returns defective cards/modules to next higher level of maintenance.
- Performs organizational level maintenance on Q-36 generator D423.

THE WEAPONS SUPPORT RADAR REPAIRER (WITH FIREFINDER RADAR REPAIRER ASI (MOSC 26B20K1))—

- Performs DS maintenance on weapons support radar systems.
- Tests and adjusts equipment.
- Determines causes of breakdowns and extent of required maintenance.
- Adjusts relays, dials, and controls.
- Replaces defective components.
- Test operates and aligns repaired equipment. Compares it with test standards.
- Performs start/stop and preventive maintenance procedures on primary power sources.
- Performs alignment procedures for radar transmitter, receiver, and computer.
- Troubleshoots malfunctioning equipment by sectionalization, localization, and isolation of malfunction to an individual component or group of components.
- Services (in addition to the three AN/TPQ-36 radars in the division) the two AN/TPQ-37 or AN/MPQ-4A radars, the AN/TPS-25 or AN/TPS-58 radar, the AN/TPA-7 trainer (if in the division), the M-36 chronograph in headquarters battery division artillery or the M90 chronographs in each firing battery, and the GMD-1 rawin set.

THE POWER GENERATION EQUIPMENT REPAIRER (MOS 52D)—

- Performs (or supervises) DS and GS maintenance on tactical utility and precise power generation equipment.
- Inspects equipment and analyzes causes of malfunctions and need for repairs.

- Maintains repair forms and records.
- Services arc welders, electric materials handling equipment, electrical load banks, motor generators, and water purification units.

Tools and Test Equipment

BITE. The Firefinder radar design includes built-in test capability. On-line status monitoring and off-line software permit rapid detection and isolation of faults and verification of repair by organization and DS repairmen.

ANCILLARY EQUIPMENT. Specific tool kits and test equipment have been assembled for organizational and DS maintenance of the Firefinder radars.

Supply

The radar section deploys with a basic load of expendables. The supported unit restocks common expendables as they are consumed. The parent TAB forwards system-peculiar expendables to the section on an as-required basis. The logistics concept for Firefinder systems should not place any unusual demands on the present supply system. Existing supply procedures apply to Firefinder.

The TAB depends on HHB, division artillery, for medical supplies, logistic support, mess, and organic vehicle maintenance. The mission may require that those supply items be provided by the unit to which a radar section is attached.

To support the maintenance concept, maximum use is made of replaceable cards that are compatible with the GS facility automatic test equipment. The following govern the supply of Firefinder-peculiar items:

Printed circuit boards and modules identified as field reparable are repaired by the GS facility equipped with automatic test equipment.

Each support level institutes a non-demand-based essential repair parts stockage list. The division TAB administers the prescribed load list. Each radar section carries organizational repair parts.

POL

The supported FA unit supplies MOGAS/diesel/common lubricants to the radar section as part of its normal POL distribution process.

Other Support

All other support for the attached radar section is worked out on an as-required basis through a close interface between the section radar technician and the supported unit commander.

6-10. Camouflage**Equipment**

The lightweight camouflage screening system (LWCSS) modules are used to camouflage the radar sets. Each module consists of one hexagon-shaped net and one diamond-shaped net with poles and accessories. More than one of these modules or any combination of the individual nets may be used (see figures 6-2 and 6-3).

There are two types of nets—radar transparent and radar scattering. The radar transparent net provides only visual camouflage and should be used in front of the radiating antenna. The radar scattering net provides camouflage against hostile radars and local infrared (IR) detection as well as visual camouflage.

There are three types of garnish on the nets; however, only the woodlands blend is available at this time. This blend is reversible to provide a summer or winter color scheme.

The following modules are required for camouflaging the set:

Installation

At the operations control group (shelter), the net is installed when the truck is pulled into position.

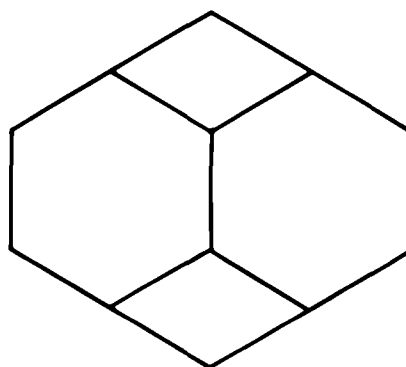


Figure 6-2. Two-module system.

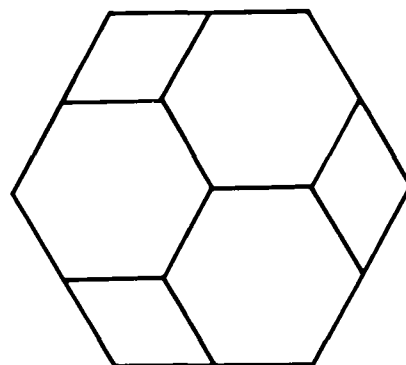


Figure 6-3. Three-module system.

EQUIPMENT	MODULES	TYPE
1¼-ton truck with S-250 shelter	2	Radar scattering
1¼-ton truck and ¾-ton trailer	2	Radar scattering
Antenna trailer	1 2	Radar scattering Radar transparent

At the antenna-transceiver group (trailer), once the jacks are lowered, the nets are installed before the antenna is raised or the generator is started.

Nets are staked to the ground all the way around and provide at least 18 inches clearance from all equipment and 48 inches clearance over the generator exhaust. Openings may be left on the side of the net away from the FEBA to allow access into the covered area.

Nets are easily damaged. They should not be dragged over equipment surfaces.

If the wind is constant at 52 mph or gusting to 75 mph, the nets may have to be lowered to prevent damage.

6-11. Shelter Operations

Whether in the friendly or hostile weapons location mode, the general organization for operation is the same. The shelter is manned by two personnel:

POSITION	MANNED BY
Supervisor	Radar warrant officer Section chief Senior radar operator
Weapon locations unit (WLU) operator	Senior radar operator Radar operator

The radar warrant officer/NCOIC makes these assignments. He considers the previous performance of section personnel and section requirements.

The operator monitors transmitter status/control panel, group status test indicators, and strip printouts for system faults. Occasional transmitter faults can be reset by pushing the fault

RESET button. If the fault does not clear after three resets, call maintenance personnel. Reset all group fault indicators as faults appear. If faults do not clear after three resets, call the maintenance personnel. For complete instructions on operator maintenance, see TM 11-5840-354-10-1, chapter 2.

The operator is responsible for TACFIRE communication.

The operator uses system function codes as necessary to control and confirm system operation. See TM 11-5840-354-10-1, pages 2-155 through 2-159, for a complete system function code list.

The following are standard procedures:

Jam strobe, auto censor, location averaging, and hostile impact predict should be enabled.

Maximum range is used unless otherwise directed.

Automatic terrain following (ATF) should be used to determine the search fence mask angle. ATF will not detect the correct screening crest if the crest is less than 750 meters from the radar antenna. For this condition, the angle of the screening crest must be measured with an aiming circle and then it must be manually inserted into the computer using the manual override ATF feature. When time permits, the entire search area mask angle should be measured with an aiming circle.

If the operator detects jamming, he should report it by the fastest secure means to the controlling headquarters.

Usually, the operator is given a primary sector of coverage. After searching this sector with no, or few, detections, he could go into the extended search mode (6,400 mils). However, this will be directed by the controlling headquarters.

6-12. Hostile Weapons Location Operating Procedures

Mission preparation consists of entering hostile search data and the priority/censor zones within the assigned sector. Data are entered during initialization or with appropriate function code if changes are required. The WLU operator enters the data supplied by the supervisor.

Radiation in the hostile weapons location mode is on a random basis when cued by the controlling headquarters. Radiation times usually are no more than 2 minutes or until queue is filled.

Duties of personnel are as follows:

Supervisor

Controls the operations in the shelter. Coordinates the functions of the operator in the shelter. Maintains log of operations.

WLU Operator

The WLU operator selects the averaging mode of operation if directed.

As each round is available in queue, he presses the DISPLAY NEXT LOCATION switch and calls the target from queue. If automatic height correction is not used, he compares the displayed altitude for the round and the altitude at the coordinates given on the map. If necessary, he corrects the altitude until elevation displayed at height display is within 10 feet of desired height or one-half contour interval. He then presses the ENTER LOCATION switch to enter the target in storage.

Hostile fire may be of such volume that the temporary storage is filled. Then the supervisor directs the operator to stop the radiating or to enter the location with low datum plane height to empty the display queue for new locations. The operator may later do height corrections when time is available. When the supervisor makes his decision, he must consider the tactical situation, counterbattery status, control headquarters guidance, EW environment, and length of time the radar has been radiating.

When required by the controlling headquarters, the operator sends the target to the designated headquarters by digital message. All hostile fire locations are sent in the fire for effect format except when a hostile location outside the supported unit's area is made or when few counterfire targets are received. In these situations, the target intelligence format is used. Procedures for sending a message to TACFIRE are in TM 11-5840-354-10-1, chapter 2, section II. If TACFIRE is not available, target locations are sent by voice over radio or land line.

6-13. Friendly Fire Mode Operations

The three friendly fire modes are impact predict (adjustment of fire), datum plane registration (mean-point-of-impact registration), and airburst registration (high-burst registration). The specific type of mission is indicated by the FDC in the message to observer. The radar system is operated the same for all three friendly fire missions when the appropriate mode is selected.

Conduct of the Mission

The friendly fire parameters are entered into the radar set, and the desired mode of operation is selected. When the radar section is ready, the section reports **READY TO OBSERVE** to the FDC. Depending on the situation, the supervisor may elect to control the firing and/or request a splash notification from the FDC. Radiation periods must be minimized during radar registration/adjustments. The radar section chief coordinates with the FDC to establish procedures to minimize radiation time; e.g., FDC gives a countdown to **SPLASH**. The radar would radiate from **SPLASH** until it had a location and then go to standby. The radar section observes as rounds are fired and transmits the data for each round to

the FDC. When released by the FDC, the section acknowledges end of mission and returns to the hostile mode in either standby or radiating.

Duties of Personnel

SUPERVISOR/SENIOR RADAR OPERATOR. Receives, records, and acknowledges message to observer from FDC and verifies the completeness of the friendly fire parameters. He instructs the WLU operator to enter the friendly fire parameters. Once these are entered, the computer automatically determines pointing azimuth and frequency elevation. Then, the supervisor notifies the FDC that the section is ready to observe and gives any modifications to the method of fire that the section desires. He monitors the radar to insure that each round is tracked and data are recorded. He verifies end of mission when all observed data are sent to the FDC.

WEAPONS LOCATION UNIT OPERATOR. On direction of the supervisor, enters the friendly fire parameters, verifies that the radar accepted the data, and requests a printout of the parameters to verify their correctness. When the mission begins, he calls each round from queue and verifies that data are complete. If directed, he transmits the data to the FDC.

The radar warrant officer or section chief selects the actual site. Additional sites are selected so an alternate position is always available. The div arty tactical operations center (TOC) (assistant TOC team chief) furnishes the SOP on the frequency and length of emissions for the radar transmitter. Radar position areas usually are in the vicinity of an artillery unit, 3 to 6 km from the forward edge of the battle area (FEBA). Section personnel and equipment are as follows:

Personnel

TITLE	GRADE	MOS	QUANTITY
Radar technician	WO	211A	1
Section chief	E6	13R30	1
Senior radar operator	E5	13R20	1
Radar operator	E3/E4	13R10	4
Radar mechanic	E4	13R10X5	1

Equipment

EQUIPMENT	QUANTITY	BTRY TOTAL
1¼-ton truck with S-250 shelter (M561)	1	3
1¼-ton truck with ¾-ton trailer (M561)	1	3
Antenna trailer (modified M116A1)	1	3
1¼-ton cargo vehicle (M884)	1	3

6-2. Duties of Personnel

The principal duties of key personnel in the AN/TPQ-36 radar section of a TAB are listed below.

Radar Technician

Advises commander and staff on equipment capabilities and use. Reconnoiters to determine actual radar site. Supervises the activities of all radar personnel in their duties.

Section Chief

Supervises operator maintenance and operation of the radar equipment. Assists the radar technician. Evaluates radar site after occupation of position.

Senior Radar Operator

Operates or supervises the operation of the radar set. Assists in the emplacement of the radar and concealment of the position. Assists the section chief in all of his duties.

Radar Operator

Operates the radar and ancillary equipment. Determines and corrects the altitudes of the weapon locations from a contour map. Transmits the final locations to a controlling headquarters. Keeps the necessary records. Operates and performs maintenance on section vehicles. Provides local security. Operates, and performs user maintenance on, section communication equipment. Operates, and

performs operator and organizational maintenance on, the power generator. Performs other duties assigned by the chief of the section.

Radar Mechanic

Performs organizational maintenance on the radar and generator. Operates radar as required. Assists the radar technician.

6-3. Organization of Personnel for Operation

A well-trained radar crew is essential for accurate, timely locations of hostile weapons. Continuous operation may be required during combat. Therefore, each man in the section must be able to perform every duty necessary to obtain and process hostile weapon locations.

For continuous operation, the section should be organized into three two-man teams. These teams exclude the radar technician and the radar mechanic, who are on call continuously. These two-man teams consist of a radar operator and an assistant, who also maintains the generator.

Section II. TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

6-4. Tactical Mission

The AN/TPQ-36 is composed of the antenna-transceiver trailer and the operations control shelter. The system is designed primarily to locate high-angle mortar, rocket, and cannon artillery firing positions. With its automatic detection, tracking, and locating process, it can consistently locate weapons firing simultaneously from multiple positions. Also, the radar can adjust friendly fire and provide registration.

The following affect the mission assigned the AN/TPQ-36 radar section:

Mission of the supported unit.

Tactics and employment techniques of the enemy artillery.

Amount and type of weapons in the enemy force and the degree to which they are active.

Capabilities and limitations of the AN/TPQ-36 radar and other target acquisition systems.

Enemy electronic countermeasures capabilities.

After considering all factors, the commander assigns a primary mission and sector(s) of search.

6-5. Selection of Site

The targeting element of the div arty TOC, under the supervision of the div arty S3, provides the radar section guidance on coordination of search areas, frequency, and length of mission.

When a radar section is attached to a field artillery unit, the positioning authority for that unit selects and coordinates position areas for the radar section. When not attached to a battalion, the TAB commander, acting as a special staff officer, advises and assists the assistant S3 for plans on the selection of position areas for elements held under div arty control. This general position area should be large enough that the radar technician or section chief may select the actual radar site based on the technical and tactical considerations affecting the operation of the radar.

If possible, the radar position should be near a field artillery unit. This would facilitate communications, survey, and logistics and take advantage of any existing defensive perimeter. The benefits of such positioning must be weighed against the hazards associated with the enemy's EW capability. Detection and location of the radar by enemy radar direction-finding equipment could reveal the location of the adjacent unit.

The radar technician or chief of section reconnoiters the general position area before selecting the actual radar site. If time permits, this reconnaissance is divided into two phases—a map reconnaissance and a ground reconnaissance.

Map Reconnaissance

The map reconnaissance is made to determine, but is not limited to, the following:

- Possible sites available
- Routes into and out of the area
- Identifying landmarks
- Locations of adjacent units

Ground Reconnaissance

A ground reconnaissance is made after the map reconnaissance to aid in occupation of the selected position. The ground reconnaissance is

based on the tactical and technical considerations for the radar as modified by the particular mission, situation, and terrain. The time available for reconnaissance is generally limited. Therefore, the reconnaissance must be organized so it can be as complete as possible in the time allotted. It must be detailed enough that the radar technician or chief of section can make decisions and issue orders concerning:

- Exact location of the radar
- Location of the radar operations center
- Location of the truck park
- Routes into and out of the area
- Searching and marking the area for mines
- Local security, to include camouflage and defense against air and ground attack
- Selection of alternate positions
- Measurement of site screening crest

6-6. Tactical Considerations

The tactical considerations in selecting a radar site are similar to those in choosing a position for a field artillery firing battery. Normally, they include communications, concealment, cover, routes of approach, security, and survey.

Communications

The system requires three AN/VRC-46 radios, wire, three TA-312/PT, and a radio set control group AN/GRA-39. Other communication needed is limited to telephones for administrative use and radios in site reconnaissance vehicles for the advance party.

The AN/TPQ-36 section operates in an operations/F net (digital) and a command net as directed by the controlling headquarters. Usually, these two nets belong to the supported DS battalion. Depending on task organization, the nets may be a digital net to the div arty TOC and a voice net to the TAB.

The radar section maintains a digital interface with the supported TACFIRE (tactical fire direction system). The preferred link is land line. If land line is not practical, the link will be the appropriate FM net. TACFIRE address and authentication identification codes are per current CEOI.

Concealment

The radar site must take advantage of natural concealment, such as trees and shrubs.

Cover

The radar should be emplaced in defilade to the enemy to give personnel and equipment all possible protection from hostile fire.

Routes of Approach

The site should have more than one route of approach to allow occupation without observation. Road conditions, overhead clearances, bridges, and stream fords must be considered.

Physical Security

If possible, the radar site should be within the defensive perimeter of another unit. This will ease the local security requirements for the radar system.

Survey

The exact radar position area must be reported to the controlling headquarters survey officer.

The required survey data and site information are provided by the survey section. A fifth-order survey is required to determine the site grid coordinates. A visible boresight reference point a minimum of 100 meters in any direction from the primary point must be established and marked to properly orient the antenna. The radar survey requirements are:

Site location (UTM easting and northing coordinates)

Site altitude

Distance from the primary site to the boresight reference point

Azimuth from the primary site to the boresight reference point

Vertical angle from the primary site to the boresight reference point

Survey data must be entered into the system during initialization. Remember that survey accuracy affects the accuracy of weapon locations.

If survey data are not available when the radar arrives at the site, the radar section performs a hasty survey and map inspection. These procedures are outlined in TM 11-5840-354-10-1, *Operators Manual for Mortar Locating Radar AN/TPQ-36*, chapter 2, section II. These data will be used until survey arrives.

Note. Usually, meteorological data are received in the radar shelter on a scheduled basis over one of the AN/VRC-46 radios. The radar uses standard met until current data become available.

6-7. Technical Considerations

A screening crest is not essential in locating hostile weapons with intercept-type radars, like the AN/TPQ-36. However, it does increase the survivability of the system. The area between the radar and the screening crest will be obscured by clutter and cannot be used for detection of weapons. Therefore, if the radar is emplaced behind a screening crest, the crest should be in friendly territory and within 1,000 meters of the radar. It is desirable that the AN/TPQ-36 radar scan at an elevation of 45 mils or less. When the automatic terrain-following (ATF) feature is used, the beam is 15 mils above the screening crest. Therefore, the vertical angle to the screening crest should not exceed 30 mils. A screening crest is also useful as a defense against electronic warfare.

Other technical considerations in selecting the radar site are:

Maximum range of the radar is 15,000 meters for mortars and artillery and 24,000 meters for short-range rockets.

Sector coverage is 1,600 mils. Sector scan of 6,400 mils may be used (1,600-mil segments).

6-8. Safety

In addition to common sense and safety procedures associated with the operation of military equipment, the following specific precautions apply to the AN/TPQ-36.

Warning

See warning page of TM 11-5840-354-10-1.

Projections

Projections from the antenna-transceiver group (trailer) are hazardous to personnel walking around the unit.

Microwave Radiation

Personnel can be exposed to microwave radiation when the transmitter is energized. Personnel in the vicinity of the antenna should insure that the XMTR power switch on the transmitter power distribution panel is in the OFF position so that personnel inside the shelter cannot accidentally operate the transmitter. If personnel must be in the vicinity of the antenna during transmitter operation, they should remain behind the antenna face.

Electronic radiation is dangerous. The hazard extends 107 meters in front of the antenna when it is in the 1,600-mil sector of scan. Radiation hazard signs will be placed a minimum of 107 meters in front of the antenna sector of scan.

Antenna Rotation

Personnel standing or working on the antenna can be injured if the antenna is rotated. They should insure that the antenna drive circuit breaker switch on the trailer power distribution panel is in the OFF position so that personnel inside the shelter cannot accidentally drive the antenna.

Generator

High-temperature areas on the generator set can result in burns. Therefore, personnel should not touch any part of the generator set except the control panel.

Hearing protection is required for personnel working within 2 meters of the generator set while it is operating.

Power Entrance Panels

Improper matching of connectors with receptacles can lead to pin damage, possibly resulting in a short. Therefore, connectors, receptacle keying, and orientation should be verified before cable connection. Cable connectors should never be forced into receptacles with mismatched keying.

Transit

A sudden stop or an accident in transit could result in damage to equipment or injury to personnel. Therefore, operating personnel will not ride either in the shelter van or on the antenna trailer. Also, all equipment panels, drawers, loose equipment, etc., must be secured before transit.

Electrical Shock

Electrical shock can cause breathing to cease. A casualty may recover if cardiopulmonary resuscitation is given promptly and efficiently. The principles and procedures for treatment for electrical shock are in FM 21-11, *First Aid for Soldiers*. All personnel should be made aware of the location of high-voltage junctions.

Maintenance

Using personnel will not maintain or inspect the radar equipment beyond those functions authorized in the appropriate technical manual.

High Wind

When the wind velocity is 52 mph or higher or gusts up to 75 mph, the antenna must be placed in the stow position.

6-9. Administrative and Logistical Support

During garrison operations, the TAB provides all administrative/logistical support for the Firefinder radar section. However, when attached to field artillery units, individual radar sections will receive such support for the more common areas of personnel services, mess, maintenance, and POL (petroleum, oil and lubricants) from the gaining unit unless otherwise specified in the attachment order.

Personnel Services

Personnel and administration support for routine actions is provided by the supported FA unit. For nonroutine actions, individual section members must be transported back to the TAB headquarters. Nonroutine actions include Uniform Code of Military Justice (UCMJ) actions, promotions, transfers, and requests for discharge.

Mail, pay, and routine distribution are consolidated by the parent unit (TAB) and forwarded by courier on a regular basis to the supported FA unit headquarters. The supported FA unit makes distribution to the radar section during normal operational runs to its subordinate batteries.

Mess

The supported FA unit supports the attached radar section in conjunction with normal operations.

Maintenance

The supported FA unit performs automotive and radio repair. Those items of equipment that must be evacuated for higher level maintenance are recovered to the parent TAB if time permits. If this is not practical, the parent TAB is informed of action taken and of the need to replace the evacuated item. The Firefinder maintenance plan uses four levels of support: organizational, direct, general, and depot.

ORGANIZATIONAL MAINTENANCE.

Ninety percent of all failures are detected and corrected at this level. Each radar section has an

organizational mechanic (MOSC 13R10 with X5 additional skill identifier (ASI)) to perform on-site maintenance. Duties include replacing malfunctioning assemblies, subassemblies, modules, and cards which are isolated by using built-in test equipment (BITE) and performing adjustments using a multimeter. Space and weight constraints limit running spares to selected modules and tools. Test equipment is limited to a Firefinder-peculiar tool kit and a multimeter. Organizational maintenance personnel use the running spares to restore the system to operation. Organizational maintenance is divided into two categories:

- **Operator maintenance tasks.** The operator monitors equipment and performs noncritical adjustments and preventive maintenance. He also performs selected repair functions, such as replacement of defective fuses, lamps, and bolts.
- **Organizational maintenance tasks.** Organizational maintenance for the radar set includes:

Performing preventive maintenance to include visual inspection, test, cleaning, tightening/adjusting, and other minor adjustments.

Making external adjustments on equipment and performing operational checks and adjustments using appropriate tools and test equipment.

Making continuity and operational checks on external interconnecting cable assemblies and performing minor cable and cable connector repair.

Analyzing the causes of equipment malfunction to the defective module (item, component, assembly, subassembly, printed/wired circuit board or card) using easy to interpret, built-in test isolation equipment. The mechanic is limited to replacement modules that are easy to remove/install and are authorized by the maintenance allocation chart (MAC). Included are those items that do not require complex or critical adjustments or system alignment after replacement. Unserviceable modules are evacuated for DS repair as prescribed by the MAC.

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At organizational level, the mean time to repair the radar is 30 minutes and the maximum time is 2 hours.

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- Unit and equipment administration number.
- Equipment location.
- Point of contact at location.
- Method of establishing direct communications with point of contact.
- As complete and correct as possible diagnosis of the nature and location of the problem and/or possible corrective action.

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equipment maintenance sections of the three forward support companies. The TAB must coordinate this support with each forward support company.

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DEPOT MAINTENANCE. Depot maintenance can completely overhaul and recondition the major end items and assemblies that are beyond the capabilities of field maintenance units. Sacramento Army Depot is designated for Firefinder.

Military Occupational Specialties (MOS)

THE FIREFINDER ORGANIZATIONAL MECHANIC (MOSC 13R10X5)—

- Operates Firefinder radar and associated equipment.
- Performs organizational maintenance on Firefinder radars.
- Assists in emplacement and march order.
- Tests the operation and evaluates the status of the radar.
- Performs inspection, preventive maintenance, and servicing to establish and maintain the radar in an acceptable operation condition.
- Performs adjustments. Uses built-in tests to detect system malfunctions and isolates them to the defective module, printed circuit board, chassis, cable, or component. Uses external test equipment as required.

- Restores equipment to operation by removing and replacing the defective item as authorized by MAC.
- Maintains work logs and prepares supply requisitions.
- Returns defective cards/modules to next higher level of maintenance.
- Performs organizational level maintenance on Q-36 generator D423.

THE WEAPONS SUPPORT RADAR REPAIRER (WITH FIREFINDER RADAR REPAIRER ASI (MOSC 26B20K1))—

- Performs DS maintenance on weapons support radar systems.
- Tests and adjusts equipment.
- Determines causes of breakdowns and extent of required maintenance.
- Adjusts relays, dials, and controls.
- Replaces defective components.
- Test operates and aligns repaired equipment. Compares it with test standards.
- Performs start/stop and preventive maintenance procedures on primary power sources.
- Performs alignment procedures for radar transmitter, receiver, and computer.
- Troubleshoots malfunctioning equipment by sectionalization, localization, and isolation of malfunction to an individual component or group of components.
- Services (in addition to the three AN/TPQ-36 radars in the division) the two AN/TPQ-37 or AN/MPQ-4A radars, the AN/TPS-25 or AN/TPS-58 radar, the AN/TPA-7 trainer (if in the division), the M-36 chronograph in headquarters battery division artillery or the M90 chronographs in each firing battery, and the GMD-1 rawin set.

THE POWER GENERATION EQUIPMENT REPAIRER (MOS 52D)—

- Performs (or supervises) DS and GS maintenance on tactical utility and precise power generation equipment.
- Inspects equipment and analyzes causes of malfunctions and need for repairs.

- Maintains repair forms and records.
- Services arc welders, electric materials handling equipment, electrical load banks, motor generators, and water purification units.

Tools and Test Equipment

BITE. The Firefinder radar design includes built-in test capability. On-line status monitoring and off-line software permit rapid detection and isolation of faults and verification of repair by organization and DS repairmen.

ANCILLARY EQUIPMENT. Specific tool kits and test equipment have been assembled for organizational and DS maintenance of the Firefinder radars.

Supply

The radar section deploys with a basic load of expendables. The supported unit restocks common expendables as they are consumed. The parent TAB forwards system-peculiar expendables to the section on an as-required basis. The logistics concept for Firefinder systems should not place any unusual demands on the present supply system. Existing supply procedures apply to Firefinder.

The TAB depends on HHB, division artillery, for medical supplies, logistic support, mess, and organic vehicle maintenance. The mission may require that those supply items be provided by the unit to which a radar section is attached.

To support the maintenance concept, maximum use is made of replaceable cards that are compatible with the GS facility automatic test equipment. The following govern the supply of Firefinder-peculiar items:

Printed circuit boards and modules identified as field repairable are repaired by the GS facility equipped with automatic test equipment.

Each support level institutes a non-demand-based essential repair parts stockage list. The division TAB administers the prescribed load list. Each radar section carries organizational repair parts.

POL

The supported FA unit supplies MOGAS/diesel/common lubricants to the radar section as part of its normal POL distribution process.

Other Support

All other support for the attached radar section is worked out on an as-required basis through a close interface between the section radar technician and the supported unit commander.

6-10. Camouflage**Equipment**

The lightweight camouflage screening system (LWCSS) modules are used to camouflage the radar sets. Each module consists of one hexagon-shaped net and one diamond-shaped net with poles and accessories. More than one of these modules or any combination of the individual nets may be used (see figures 6-2 and 6-3).

There are two types of nets—radar transparent and radar scattering. The radar transparent net provides only visual camouflage and should be used in front of the radiating antenna. The radar scattering net provides camouflage against hostile radars and local infrared (IR) detection as well as visual camouflage.

There are three types of garnish on the nets; however, only the woodlands blend is available at this time. This blend is reversible to provide a summer or winter color scheme.

The following modules are required for camouflaging the set:

Installation

At the operations control group (shelter), the net is installed when the truck is pulled into position.

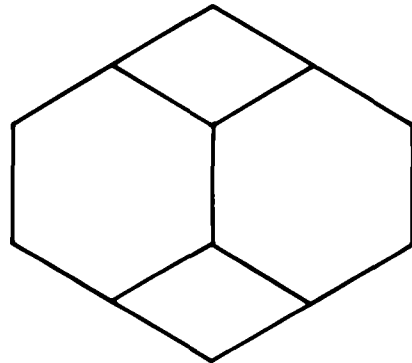


Figure 6-2. Two-module system.

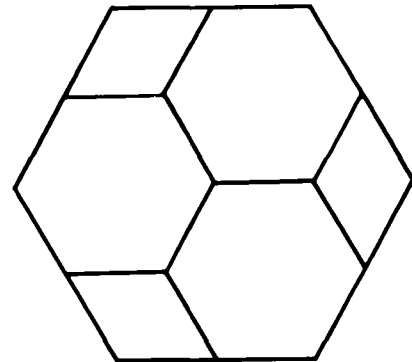


Figure 6-3. Three-module system.

EQUIPMENT	MODULES	TYPE
1¼-ton truck with S-250 shelter	2	Radar scattering
1¼-ton truck and ¾-ton trailer	2	Radar scattering
Antenna trailer	1 2	Radar scattering Radar transparent

At the antenna-transceiver group (trailer), once the jacks are lowered, the nets are installed before the antenna is raised or the generator is started.

Nets are staked to the ground all the way around and provide at least 18 inches clearance from all equipment and 48 inches clearance over the generator exhaust. Openings may be left on the side of the net away from the FEBA to allow access into the covered area.

Nets are easily damaged. They should not be dragged over equipment surfaces.

If the wind is constant at 52 mph or gusting to 75 mph, the nets may have to be lowered to prevent damage.

6-11. Shelter Operations

Whether in the friendly or hostile weapons location mode, the general organization for operation is the same. The shelter is manned by two personnel:

POSITION	MANNED BY
Supervisor	Radar warrant officer Section chief Senior radar operator
Weapon locations unit (WLU) operator	Senior radar operator Radar operator

The radar warrant officer/NCOIC makes these assignments. He considers the previous performance of section personnel and section requirements.

The operator monitors transmitter status/control panel, group status test indicators, and strip printouts for system faults. Occasional transmitter faults can be reset by pushing the fault

RESET button. If the fault does not clear after three resets, call maintenance personnel. Reset all group fault indicators as faults appear. If faults do not clear after three resets, call the maintenance personnel. For complete instructions on operator maintenance, see TM 11-5840-354-10-1, chapter 2.

The operator is responsible for TACFIRE communication.

The operator uses system function codes as necessary to control and confirm system operation. See TM 11-5840-354-10-1, pages 2-155 through 2-159, for a complete system function code list.

The following are standard procedures:

Jam strobe, auto censor, location averaging, and hostile impact predict should be enabled.

Maximum range is used unless otherwise directed.

Automatic terrain following (ATF) should be used to determine the search fence mask angle. ATF will not detect the correct screening crest if the crest is less than 750 meters from the radar antenna. For this condition, the angle of the screening crest must be measured with an aiming circle and then it must be manually inserted into the computer using the manual override ATF feature. When time permits, the entire search area mask angle should be measured with an aiming circle.

If the operator detects jamming, he should report it by the fastest secure means to the controlling headquarters.

Usually, the operator is given a primary sector of coverage. After searching this sector with no, or few, detections, he could go into the extended search mode (6,400 mils). However, this will be directed by the controlling headquarters.

6-12. Hostile Weapons Location Operating Procedures

Mission preparation consists of entering hostile search data and the priority/censor zones within the assigned sector. Data are entered during initialization or with appropriate function code if changes are required. The WLU operator enters the data supplied by the supervisor.

Radiation in the hostile weapons location mode is on a random basis when cued by the controlling headquarters. Radiation times usually are no more than 2 minutes or until queue is filled.

Duties of personnel are as follows:

Supervisor

Controls the operations in the shelter. Coordinates the functions of the operator in the shelter. Maintains log of operations.

WLU Operator

The WLU operator selects the averaging mode of operation if directed.

As each round is available in queue, he presses the DISPLAY NEXT LOCATION switch and calls the target from queue. If automatic height correction is not used, he compares the displayed altitude for the round and the altitude at the coordinates given on the map. If necessary, he corrects the altitude until elevation displayed at height display is within 10 feet of desired height or one-half contour interval. He then presses the ENTER LOCATION switch to enter the target in storage.

Hostile fire may be of such volume that the temporary storage is filled. Then the supervisor directs the operator to stop the radiating or to enter the location with low datum plane height to empty the display queue for new locations. The operator may later do height corrections when time is available. When the supervisor makes his decision, he must consider the tactical situation, counterbattery status, control headquarters guidance, EW environment, and length of time the radar has been radiating.

When required by the controlling headquarters, the operator sends the target to the designated headquarters by digital message. All hostile fire locations are sent in the fire for effect format except when a hostile location outside the supported unit's area is made or when few counterfire targets are received. In these situations, the target intelligence format is used. Procedures for sending a message to TACFIRE are in TM 11-5840-354-10-1, chapter 2, section II. If TACFIRE is not available, target locations are sent by voice over radio or land-line.

6-13. Friendly Fire Mode Operations

The three friendly fire modes are impact predict (adjustment of fire), datum plane registration (mean-point-of-impact registration), and airburst registration (high-burst registration). The specific type of mission is indicated by the FDC in the message to observer. The radar system is operated the same for all three friendly fire missions when the appropriate mode is selected.

Conduct of the Mission

The friendly fire parameters are entered into the radar set, and the desired mode of operation is selected. When the radar section is ready, the section reports READY TO OBSERVE to the FDC. Depending on the situation, the supervisor may elect to control the firing and/or request a splash notification from the FDC. Radiation periods must be minimized during radar registration/adjustments. The radar section chief coordinates with the FDC to establish procedures to minimize radiation time; e.g., FDC gives a countdown to SPLASH. The radar would radiate from SPLASH until it had a location and then go to standby. The radar section observes as rounds are fired and transmits the data for each round to

the FDC. When released by the FDC, the section acknowledges end of mission and returns to the hostile mode in either standby or radiating.

Duties of Personnel

SUPERVISOR/SENIOR RADAR OPERATOR. Receives, records, and acknowledges message to observer from FDC and verifies the completeness of the friendly fire parameters. He instructs the WLU operator to enter the friendly fire parameters. Once these are entered, the computer automatically determines pointing azimuth and frequency elevation. Then, the supervisor notifies the FDC that the section is ready to observe and gives any modifications to the method of fire that the section desires. He monitors the radar to insure that each round is tracked and data are recorded. He verifies end of mission when all observed data are sent to the FDC.

WEAPONS LOCATION UNIT OPERATOR. On direction of the supervisor, enters the friendly fire parameters, verifies that the radar accepted the data, and requests a printout of the parameters to verify their correctness. When the mission begins, he calls each round from queue and verifies that data are complete. If directed, he transmits the data to the FDC.

★CHAPTER 7

FIREFINDER ARTILLERY LOCATING RADAR

SET AN/TPQ-37

Section I. Organization

	Paragraph		Paragraph
Organization of the AN/TPQ-37		Tactical Considerations	7-6
Radar Section	7-1	Technical Considerations	7-7
Duties of Personnel	7-2	Safety	7-8
Organization of Personnel		Administrative and	
for Operation	7-3	Logistical Support	7-9
Section II. Tactical Employment and		Camouflage	7-10
Position Requirements		Shelter Operations	7-11
Tactical Mission	7-4	Hostile Weapons Location	
Selection of Site	7-5	Operating Procedures	7-12
		Friendly Fire Mode	
		Operations	7-13

The artillery locating radar AN/TPQ-37 detects and locates enemy short- and long-range artillery and rocket weapons quickly and accurately enough for immediate engagement by friendly counterfire. The radar locates a weapon position by automatically detecting and tracking a projectile to determine the point of origin. The

weapon location is then displayed to the radar operator and can be sent to the artillery fire direction center (FDC), stored by the radar's computer, or deleted as the situation dictates. The radar also can register and adjust friendly indirect fire. The AN/TPQ-37 uses a combination of radar techniques and computer-controlled signal

processing to detect, verify, and track targets. The phased-array antenna allows the radar to electronically switch beam positions. Thus, it can search for new targets and simultaneously track targets already detected. It also enables the radar to detect and locate weapons firing simultaneously from multiple positions. The system provides sufficient track data to locate firing positions on the first detected round at ranges from 3 km to 50 km, depending on the weapon type.

The AN/TPQ-37 system is a transportable, tactical radar carried on two vehicles (fig 7-1). One vehicle carries the S-250 central data shelter. This shelter contains the data processing, electronics, and display and control equipment. Subsystems include the video and signal processor, radar buffer/synchronizer, radar set control, magnetic tape cassette cartridge, B-scope, TACFIRE interface, and radio and wire communications. All mission-essential components can be transported by standard military vehicles, medium-lift helicopters, and C-130 type aircraft.

The prime power unit (PPU) consists of a 60-kw, 400-Hz precision generator. The generator and cable reels are mounted on a special platform that secures the PPU to an M813 5-ton truck. The truck also tows the antenna assembly trailer (AAT). The AAT houses the S-band phased-array antenna, transmitter subsystem, receiver/exciter group, beam steering unit, power distribution unit, power supplies, tilt sensor kit, and transporter controls. The antenna is mounted on a pedestal attached to the transporter base, which is supported by a four-wheeled M832 dolly set. The antenna is pivoted at the bottom and can be raised or lowered by an electric motor. A motor also drives the pedestal to allow 6,400-mil antenna azimuth traverse. When operationally deployed, the antenna stands 17-feet high. A boresight telescope is mounted on the antenna to orient the system optically during emplacement. Data and power cables connect the AAT with the central data shelter and the PPU. The AAT has a walk-in maintenance aisle to allow easy access to the hardware.

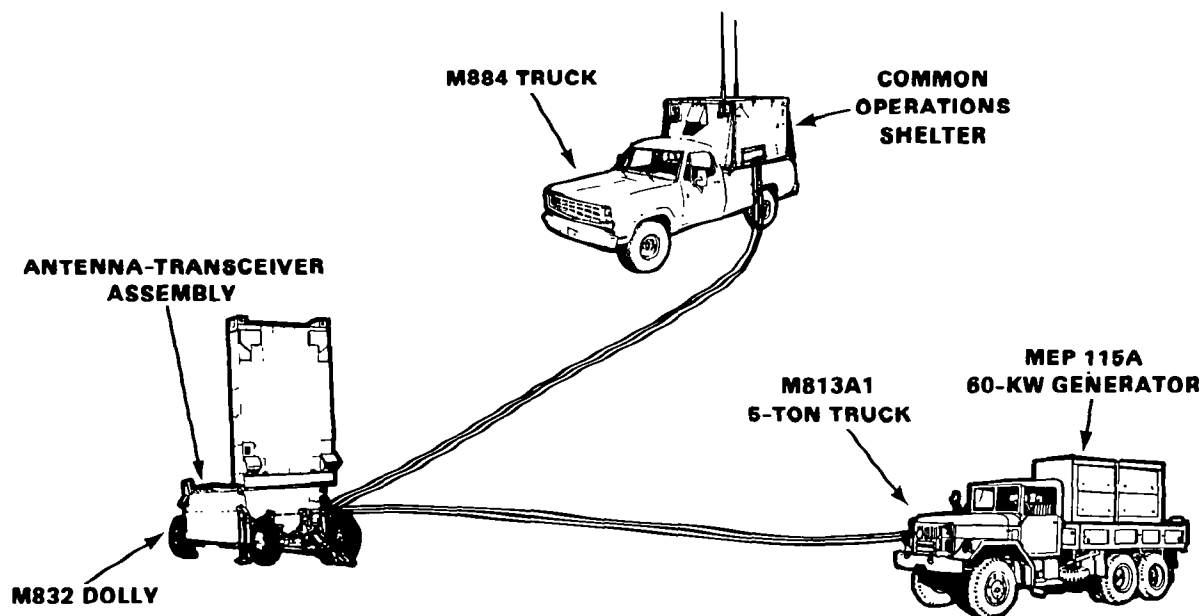


Figure 7-1. AN/TPQ-37 radar system.

Section I. ORGANIZATION

7-1. Organization of the AN/TPQ-37 Radar Section

There are two AN/TPQ-37 radar sets in each target acquisition battery (TAB). Both AN/TPQ-37 radars are allocated by the division artillery (div arty) S3 across the division front. Allocation is based on command guidance, terrain, and the enemy situation. The radars are usually under the operational control of the div arty tactical operations center (TOC) except when attached to another field artillery unit. Guidance on coordination of search areas, frequency, and length of mission is provided to the radar section by the target element of the div arty TOC under the supervision of the div arty S3. The platoon leader, radar warrant officer, or chief of section selects

suitable radar positions. Selection is based on the tactical and technical considerations affecting the operation of the radar. Additional sites are selected so that an alternate position is always available. When possible, the site should be within an established perimeter of defense to lighten the additional duty of security for radar personnel. This also allows the survey section to more rapidly provide the required fourth-order survey for the radar set. The div arty TOC establishes guidance on the frequency and length of emissions for the radar transmitter. To reduce its vulnerability and increase its effectiveness, emission times are cued by controlling headquarters. The actual distance, behind the forward edge of the battle area (FEBA), the radar is located depends upon the mission, terrain, and situation. Section personnel and equipment are as follows:

Personnel

TITLE	GRADE	MOS	QUANTITY
Radar technician	WO	211A	1
Section chief	E6	13R30	1
Senior radar operator	E5	13R20	1
Radar operator	E3/E4	13R10	7
Radar mechanic	E4	13R10X5	1
Light wheel vehicle/ power generator mechanic	E4	63B10	1

Equipment

EQUIPMENT	QUANTITY	BTRY TOTAL
1¼-ton truck with S-250 shelter (M884)	1	2
5-ton truck with generator	1	2
Antenna trailer	1	2
1¼-ton cargo vehicle (M884) with trailers	2	4

7-2. Duties of Personnel

The principal duties of key personnel in the AN/TPQ-37 radar section of a TAB are listed below.

Radar Technician

Advises commander and staff on equipment capabilities and use. Reconnoiters to determine actual radar site. Supervises the activities of all radar personnel in their duties.

Section Chief

Supervises operator maintenance and operation of the radar equipment. Assists the radar technician. Evaluates radar site after occupation of position.

Senior Radar Operator

Operates or supervises the operation of the radar set. Assists in the emplacement of the radar and concealment of the position. Assists the section chief in all of his duties.

Radar Operator

Operates the radar and ancillary equipment. Determines and corrects the altitudes of the weapon locations from a contour map. Transmits the final locations to a controlling headquarters. Keeps the necessary records.

Operates the radar's prime movers. Performs scheduled maintenance on the prime movers. Provides local security. Operates, and performs user maintenance on, communications equipment organic to the radar section. Performs other duties assigned by the chief of the section.

Radar Mechanic

Performs organizational maintenance. Operates the radar as required. Assists the radar technician.

Light Wheel Vehicle/Power Generator Mechanic

Operates, and performs operator and organizational maintenance on, the power generator. Provides local security. Assists in the operation of the radar set during periods of intense enemy weapon activity.

7-3. Organization of Personnel for Operation

A well-trained radar crew is essential for accurate, timely locations of hostile weapons. Continuous operation may be required during combat. Therefore, each man in the section must be able to perform every duty necessary to obtain and process hostile weapon locations.

For continuous operation, the section should be organized into four two-man teams. These teams exclude the chief of section, the radar mechanic, and the generator operator/mechanic, who are on call continuously. These two-man teams consist of a radar operator and an assistant, who also assists in the maintenance of the generator.

Section II. TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

7-4. Tactical Mission

The AN/TPQ-37 is a mobile radar capable of accurately locating hostile artillery and rockets at their normal firing ranges. To cover the division zone of responsibility, radar positions are located 8 to 12 km from the FEBA, across the division front.

The radar usually is under the control of the div arty TOC and passes target information directly to its target acquisition processing section. The radar may be directed to pass targets to a direct support (DS) or general support (GS) battalion or to a field artillery brigade. In such cases, the supported unit S3 designates a radio net frequency to be used.

The div arty TOC establishes policies on the frequency and length of transmissions for the radar. Threat artillery activity is the most important consideration. The transmission will be no longer than necessary, usually no more than 2 minutes for any one period. This allows the radar to effectively locate weapons yet reduces its vulnerability to detection.

The radar is designed to operate in all world climates and terrain. Certain precautions must be taken when the following extremes exist: moist or dry heat, rainfall, cold, salt or sea air, dust storms, or sandstorms. See TM 11-5840-355-10-1, *Operators Manual for Artillery Locating Radar AN/TPQ-37*, section V, for these precautions.

Usually, the radar is located adjacent to a friendly field artillery unit, preferably a firing battery of the GS battalion. A coordinated defense

plan is completed for mutual defense. Foxholes and machinegun positions are completed as time permits. At least one listening post is occupied to provide warning for defense of the position or movement to an alternate position.

7-5. Selection of Site

Before his reconnaissance to select the actual radar site and alternate positions, the radar technician is briefed on:

- Tactical situation
- Primary radar mission
- Enemy electronic warfare (EW) capabilities/activities
- Availability of survey
- Local security requirements
- Communications
- Priority zones
- Censor zones
- Availability of met
- Center of sector
- Left and right limits
- Range to be used
- Primary target zone information or overlay
- Logistic support

The radar technician or section chief conducts a map, then a ground, reconnaissance, if possible, to select the exact radar site and alternate positions. The recon party consists of the radar technician or section chief, a driver, and another section member for additional security. The reconnaissance is made in a 1¼-ton truck without trailer. In selecting the positions, the radar technician or section chief considers entrance and egress routes, natural cover and concealment, location of adjacent units, ability to cover the desired sector, and screening crests to increase survivability and defend against electronic warfare. With the aiming circle, he measures the vertical angle to the screening crest from the actual antenna site and records it for use during initialization.

In the forward position, the party checks for and, as necessary, clears obstacles, booby traps, mines, and nuclear, biological, chemical contamination.

When the exact site has been selected, it is immediately reported to the div arty TOC and the supporting recon and survey officer.

Site survey requirements before occupation of radar are:

Primary site UTM easting and northing (fourth-order survey)

Primary site altitude

Distance to orienting point

Azimuth to orienting point

Vertical angle to orienting point

If survey is not available before the radar arrives, the radar technician performs hasty survey operations in accordance with the appropriate TM. Those data are used until survey is provided. If time is a factor, the radar technician uses resection or intersection to obtain survey data.

Usually, met data are sent by FM radio to the radar operator in the old location on a scheduled basis. When met data have not been received, they are requested from the div arty TOC. If that request is not answered, standard met will be used.

7-6. Tactical Considerations

The tactical considerations in selecting a radar site are similar to those in choosing a position for a field artillery firing battery. Normally, they include communications, concealment, cover, routes of approach, security, and survey.

Communications

The system requires three AN/VRC-46 radios, wire, one radio set control group AN/GRA-39, and three telephone sets TA-312/PT. Other requirements are for telephones for administrative use.

The AN/TPQ-37 operates in a TAB command intelligence (CI) net (digital) and a command net as directed by the controlling headquarters. Usually, these two nets belong to the division artillery. Depending on the task organization, the nets may be a battalion operations/F net and a command net.

The radar section maintains a digital interface with the supported TACFIRE (tactical fire direction system) through a designated net. The preferred link is land line. If land line is not practical, the link will be the appropriate FM net. TACFIRE address and authentication codes are per current CEOI.

Concealment

The radar site must take advantage of natural concealment, such as trees and shrubs.

Cover

The radar should be emplaced in defilade to the enemy to give personnel and equipment all possible protection from hostile fire.

Routes of Approach

The site should have more than one route of approach to allow occupation without enemy observation. Road conditions, overhead clearances, bridges, and stream fords must be considered.

Physical Security

If possible, the radar site should be within the defense perimeter of another unit. This will

ease the local security requirements for the radar system.

Survey

The exact radar position area must be reported to the controlling headquarters survey officer.

The required survey data and site information are provided by the survey section. Because of the extended range of the AN/TPQ-37, directional control of fourth order is required. In the normal role, when the AN/TPQ-37 is working directly with the div arty TACFIRE, survey data are provided on a priority basis by one of the two survey parties of the TAB or the div arty HHB. When the radar is deployed on a wide front, reporting to an artillery brigade or battalion TACFIRE set, and in the counterbattery role, the required survey data are provided by the battalion survey section. The radar survey requirements are:

Site location (UTM easting and northing coordinates)

Site altitude

Distance from the primary site to the boresight reference point

Azimuth from the primary site to the boresight reference point

Vertical angle from the primary site to the boresight reference point

Survey data must be entered into the system during initialization. Remember that survey accuracy affects the accuracy of weapon locations.

If survey data are not available when the radar arrives at the site, the radar section performs a hasty survey and map inspection. These procedures are outlined in the AN/TPQ-37 operators manual. These data will be used until survey arrives.

7-7. Technical Considerations

A screening crest is not essential in locating hostile weapons with tracking radars.

However, it does increase the survivability of the system. It is useful as a defense against electronic warfare. If the radar is emplaced behind a screening crest, one of the following conditions must be met to prevent a multipath induced error:

The terrain should gradually slope downward from the radar system for about 150 to 300 meters and then rise sharply to a maximum of 25 mils (as measured from the radar).

The terrain should gradually slope downward from the radar system for about 150 to 300 meters and then rise gradually to a maximum of 25 mils (as measured from the radar).

The terrain should remain level from the radar system for about 150 to 300 meters and then rise gradually or sharply to a maximum of 25 mils (as measured from the radar).

Other technical considerations in selecting the radar site are the maximum range of the radar (50,000 meters) and the sector coverage (1,600 mils).

7-8. Safety

In addition to common sense and safety procedures associated with the operation of military equipment, the following specific precautions apply to the AN/TPQ-37.

Warning

See warning pages a, b, and c of TM 11-5840-355-10-1.

Projections

Projections from the antenna-transceiver group (trailer) are hazardous to personnel walking around the unit.

Microwave Radiation

Personnel can be exposed to microwave radiation when the transmitter is energized. Personnel in the vicinity of the antenna should insure that the XMTR power switch on the transmitter power distribution panel is in the OFF

position so that personnel inside the shelter cannot accidentally energize the transmitter. Personnel should remain behind the antenna face.

Electronic radiation is dangerous. The hazard extends 141 meters in front of the antenna when it is in the 1,600-mil sector of scan. Radiation hazard signs will be placed a minimum of 141 meters in front of the antenna sector of scan.

Antenna Rotation

Personnel standing or working on the antenna can be injured if the antenna is rotated. They should insure that the antenna drive circuit breaker switch on the trailer power distribution panel is in the OFF position so that personnel inside the shelter cannot accidentally drive the antenna.

Generator

High-temperature areas on the generator set can result in burns. Therefore, personnel should not touch any part of the generator set except the control panel.

Hearing protection is required for personnel working within 2 meters of the generator set while it is operating.

Power Entrance Panels

Improper matching of connectors with receptacles can lead to pin damage, possibly resulting in a short. Therefore, connectors, receptacle keying, and orientation should be verified before cable connection. Cable connectors should never be forced into receptacles with mismatched keying.

Transit

A sudden stop or accident in transit could result in damage to equipment or injury to personnel. Therefore, operating personnel will not ride either in the shelter van or on the antenna trailer. Also, all equipment panels, drawers, loose equipment, etc., must be secured before transit.

Electrical Shock

Electrical shock can cause breathing to cease. A casualty may recover if cardiopulmonary resuscitation is given promptly and efficiently. The principles and procedures for treatment for

electrical shock are in FM 21-11. All personnel should be made aware of the location of high-voltage junctions.

Maintenance

Using personnel will not maintain or inspect the radar equipment beyond those functions authorized in the appropriate technical manual.

High Wind

When wind velocity is 40 mph or higher or gusts up to 75 mph, the antenna must be placed in the stow position.

7-9. Administrative and Logistical Support

During garrison operations, the TAB provides all administrative/logistical support for the Firefinder radar section. However, when deployed, individual radar sections must receive such support for the more common areas of personnel services, mess, maintenance, and POL supply from the unit to which attached.

Personnel Services

Personnel and administration support for routine actions is provided by the supported FA unit. For nonroutine actions, individual section members must be transported back to the TAB headquarters. Nonroutine actions include UCMJ actions, promotions, transfers, and requests for discharge.

Mail, pay, and routine distribution are consolidated by the parent unit (TAB) and forwarded by courier on a regular basis to the supported FA unit headquarters. The supported FA unit makes distribution to the radar section during normal operational runs to its subordinate batteries.

Mess

The supported FA unit supports the attached radar section in conjunction with normal operations.

Maintenance

The supported FA unit performs automotive and radio repair. Those items of equipment that must be evacuated to a higher level maintenance facility are recovered to the parent TAB if time permits. If this is not practical, the parent TAB is informed of action taken and of the need to replace the evacuated item. The Firefinder maintenance plan uses four levels of support: organizational, direct, general, and depot.

ORGANIZATIONAL MAINTENANCE.

Ninety percent of all failures are detected and corrected at this level. Each radar section has an organizational mechanic (MOSC 13R10 with X5 ASI) to perform on-site maintenance. Duties include replacing malfunctioning assemblies, subassemblies, modules, and cards which are isolated by using built-in test equipment (BITE) and performing adjustments using a multimeter. Space and weight constraints limit running spares to selected modules and tools. Test equipment is limited to a Firefinder-peculiar tool kit and a multimeter. Organizational maintenance personnel use the running spares to restore the system to an operational status. Organizational maintenance is divided into two categories:

- Operator maintenance tasks. The operator monitors equipment and performs noncritical adjustments and preventive maintenance. He also performs selected repair functions, such as replacement of defective fuses, lamps, and bolts.
- Organizational maintenance tasks. The organizational maintenance function for the radar set includes:

Performing preventive maintenance to include visual inspection, test, cleaning, tightening/adjusting, and other minor adjustments.

Making external adjustments on equipment and performing operational checks and adjustments using appropriate tools and test equipment.

Making continuity and operational checks on external interconnecting cable assemblies and performing minor cable and cable connector repair.

Analyzing the causes of equipment malfunction to the defective module (item, component, assembly, subassembly, printed/wired circuit board or card) using easy to interpret, built-in test isolation equipment. The mechanic is limited to replacement modules, which are easy to remove/install and authorized by the maintenance allocation chart (MAC). Included are those items that do not require complex or critical adjustments or system alinement after replacement. Unserviceable modules are evacuated for DS repair as prescribed by the MAC.

The light wheel vehicle/power generator mechanic (MOSC 63B10) is responsible for operator and organizational maintenance on the AN/TPQ-37 power generator (MEP 115A).

At organizational level, the mean time to repair the radar is 30 minutes and the maximum time is 2 hours.

DIRECT SUPPORT MAINTENANCE.

Requests for direct support are originated by the organizational mechanic with the concurrence of the radar technician. The requests go through the controlling unit headquarters (for attached radars) or through the TAB headquarters (for GS radars). Requests are processed by the fastest means consistent with security considerations to the appropriate DS maintenance battalion. The TAB commander is advised of all such requests to insure that support response is in keeping with the commander's counterfire priorities. The information required is:

- Unit and equipment administration number.
- Equipment location.
- Point of contact at location.
- Method of establishing direct communications with point of contact.
- As complete and correct as possible diagnosis of the nature and location of the problem and/or possible corrective action.

The Firefinder DS maintenance is provided by the headquarters and light maintenance company. The weapons support radar repairer (MOSC 26B20 with K1 ASI) is a member of the electronic maintenance section. He performs selected tests and repairs/replaces components in

a van-mounted repair facility. He has a complete set of tools, test equipment, and repair parts at his disposal. This facility is in the division support area, and usually a radar must be evacuated to that location for major repair. As necessary, he may join the TACFIRE maintenance support team of the heavy maintenance company or be transported by radar section or TAB personnel to perform on-site maintenance.

DS maintenance for the Q-37 generator is provided by the power generation equipment repairmen (MOS 52D) assigned to the generator equipment maintenance sections of the three forward support companies. The TAB must coordinate this support with each forward support company.

At DS level, the mean time to repair the radar is 2 hours. Maximum time is 4 hours with two persons, one of which must be a 26B20K1.

GENERAL SUPPORT MAINTENANCE. GS maintenance of Firefinder-peculiar items is limited to repair of printed circuit boards by the GS facility using automatic test equipment. The facility repairs unserviceable items and returns them to stock or evacuates them to the repair facility designated in the MAC.

GS maintenance for Firefinder associated support equipment is performed by the responsible elements of the corps GS maintenance battalion.

DEPOT MAINTENANCE. Depot maintenance can completely overhaul and recondition the major end items and assemblies that are beyond the capabilities of field maintenance units. Sacramento Army Depot is designated for Firefinder.

Military Occupational Specialties (MOS)

THE FIREFINDER ORGANIZATIONAL MECHANIC (MOSC 13R10X5)—

- Operates Firefinder radar and associated equipment.
- Performs organizational maintenance on Firefinder radars.
- Assists in emplacement and march order.
- Tests the operation and evaluates the status of the radar.

- Performs inspection, preventive maintenance, and servicing to establish and maintain the radar in an acceptable operation condition.

- Performs adjustments. Uses system built-in tests to detect system malfunctions and isolates them to the defective module, printed circuit board, chassis, cable, or component. Uses external test equipment as required.

- Restores equipment to operation by removing and replacing the defective item as authorized by MAC.

- Maintains work logs and prepares supply requisitions.

- Returns defective cards/modules to next higher level of maintenance.

THE POWER GENERATOR AND WHEELED VEHICLE MECHANIC (MOSC 63B10)—

- Applies knowledge of operating principles of internal combustion engines and accessories and power train and chassis components to repair and maintain wheeled vehicles, material-handling equipment, tactical utility and precise power generation equipment, and associated equipment.

- Lubricates and changes oil, filters, and cleaners.

- Cleans vehicle, equipment, and components.

- Tightens and replaces clamps, bolts, and connectors.

- Tests, cleans, and services batteries.

- Drains/flushes radiators, fills with coolant.

- Troubleshoots mechanical, electrical, and hydraulic systems/components.

- Adjusts to insure balance or load-phase relationship and effective functioning of equipment.

- Computes voltage, amperage, and resistance factors. Prepares equipment for operations under abnormal conditions.

- Diagnoses and isolates causes of malfunctions.

- Tunes engine, replaces components, and test operates repaired equipment.

- Road tests, repairs tires and tubes, uses hand tools, and operates power equipment.

- Prepares maintenance forms, records, and reports.

THE WEAPONS SUPPORT RADAR REPAIRER (WITH FIREFINDER RADAR REPAIRER ASI (MOSC 26B20K1)—

- Performs DS maintenance on weapons support radar systems.
- Tests and adjusts equipment.
- Determines causes of breakdowns and extent of required maintenance.
- Adjusts relays, dials, and controls.
- Replaces defective components.
- Test operates and aligns repaired equipment. Compares it with test standards.
- Performs start/stop and preventive maintenance procedures on primary power sources.
- Performs alignment procedures for radar transmitter, receiver, and computer.
- Troubleshoots malfunctioning equipment by sectionalization, localization, and isolation of malfunction to an individual component or group of components.
- Services (in addition to the two AN/TPQ-37 radars in the division) the three AN/TPQ-36 or AN/MPQ-4A radars, the AN TPS-25 or AN/TPS-58 radar, the AN/TPA-7 trainer (if in the division), the M-36 chronograph in headquarters battery division artillery or the M90 chronographs in each firing battery, and the GMD-1 rawin set.

THE POWER GENERATION EQUIPMENT REPAIRER (MOS 52D)—

- Performs or supervises DS and GS maintenance on tactical utility and precise power generation equipment.
- Inspects equipment and analyzes causes of malfunctions and need for repairs.
- Maintains repair forms and records.
- Services arc welders, electric materials handling equipment, electrical load banks, motor generators, and water purification units.

Tools and Test Equipment

BITE. The Firefinder radar design includes built-in test capability. On-line status monitoring and off-line software permit rapid detection and

isolation of faults and verification of repair by organization and DS repairmen.

ANCILLARY EQUIPMENT. Specific tool kits and test equipment have been assembled for organizational and DS maintenance of the Firefinder radars.

Supply

The radar section deploys with a basic load of expendables. The supported unit restocks common expendables as they are consumed. The parent TAB forwards system-peculiar expendables to the section on an as-required basis. The logistics concept for Firefinder systems should not place any unusual demands on the present supply system. Existing supply procedures apply to Firefinder.

The TAB depends on HHB, division artillery, for medical supplies, logistic support, mess, and organic vehicle maintenance. The mission may require that those supply items be provided by the unit to which a radar section is attached.

To support the maintenance concept, maximum use is made of replaceable cards that are compatible with the GS facility automatic test equipment. The following govern the supply of Firefinder-peculiar items:

Printed circuit boards and modules identified as field reparable are repaired by the GS facility equipped with automatic test equipment.

Each support level institutes a non-demand-based essential repair parts stockage list. Each radar section carries organizational repair parts.

POL

The supported FA unit supplies MOGAS/diesel/common lubricants to the radar section as part of its normal POL distribution process.

Other Support

All other support for the attached radar section is worked out on an as-required basis through a close interface between the section radar technician and the supported unit commander.

7-10. Camouflage

Unless specifically directed otherwise by the radar technician/section chief, nets are erected in every position area over all section vehicles. Nets may have to be lowered if wind is constant at 40 mph or gusts to 75 mph.

Equipment

The section uses the lightweight camouflage screening system (LWCSS). One module consists of a hexagon-shaped net and a diamond-shaped net with poles and accessories. These modules can be used in any combination (fig 7-2).

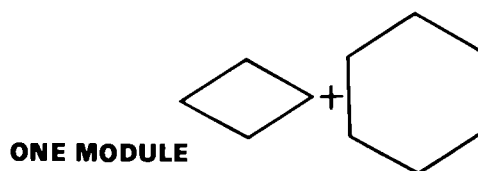
There are two types of nets—radar scattering and radar transparent. There are three blends of camouflage for each type of net—woodland, desert, and snow. The section uses the radar scattering woodland blend (NSN 1080-00-103-1246), which protects from infrared, radar, and visual detection. Appropriate supply action is initiated if the section is to deploy to a desert or snow environment.

Generally, from April through September, the net's summer shade is used; and from October through March, the winter shade is used.

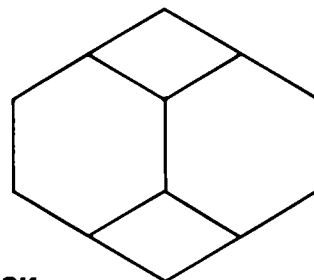
Installation

A 1¼-ton truck (with or without trailer) requires two modules; a 5-ton truck requires four.

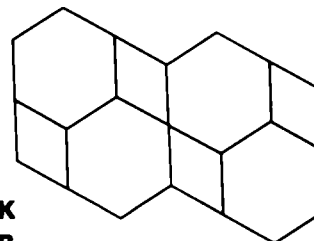
Nets are staked to the ground all the way around the equipment to provide at least 18 inches clearance from the equipment and 48 inches clearance from the generator exhaust. There will be an opening on the side away from the FEBA for an entrance/exit.



ONE MODULE



**TWO MODULES
FOR 1¼-TON TRUCK
WITH OR WITHOUT ¾-TON TRAILER**



**FOUR MODULES
FOR 5-TON TRUCK
WITH GENERATOR**

Figure 7-2. Camouflage nets.

7-11. Shelter Operations

Whether in the friendly or hostile weapons location mode, the general organization for operation is the same. The shelter is manned by two personnel:

POSITION	MANNED BY
Supervisor	Radar warrant officer Section chief Senior radar operator
Weapon locations unit (WLU) operator	Radar operator

The radar warrant officer/section chief makes these assignments. He considers the previous performance of section personnel and section requirements.

The operator monitors transmitter status/control panel, group status test indicators, computer status, and line printer printouts for system faults. Occasional transmitter faults can be reset by pushing the fault RESET. If the fault does not clear after three resets, call maintenance personnel. Reset all group fault indicators as faults appear. If faults do not clear after three resets, call maintenance personnel. For complete instructions on operator maintenance, see TM 11-5840-355-10-1, chapter 2.

The operator is responsible for TACFIRE communication.

The operator uses system function codes as necessary to control and confirm system operation. See TM 11-5840-355-10-1, pages 2-3 to 2-5, for a complete function code list.

The following are standard procedures:

Jam strobe, auto censor, location averaging, and hostile impact predict should be enabled.

Maximum range is used unless otherwise directed.

Automatic terrain following should be used if feasible.

If the operator detects jamming, he should report it by the fastest means to the controlling headquarters.

Usually, the operator is given a primary sector of coverage. After searching this sector with no or few detections, he should go into another sector of search. However, this will be directed by the controlling headquarters.

7-12. Hostile Weapons Location Operating Procedures

Mission preparation consists of entering hostile search data and the priority/censor zones

within the assigned sector. Data are entered during initialization or with appropriate function code if changes are required. The WLU operator enters the data supplied by the supervisor.

Radiation in the hostile weapons location mode is on a random basis when cued by the controlling headquarters. Radiation times usually are no more than 2 minutes or until a queue is filled.

Duties of personnel are as follows:

Supervisor

Controls the operation in the shelter. Coordinates the functions of the operator in the shelter. Maintains log of operations.

WLU Operator

The WLU operator selects the averaging mode of operation if directed.

As each round is available in queue, he presses the DISPLAY NEXT LOCATION switch and calls the target from queue. If automatic height correction is not used, he compares the displayed altitude for the round and the altitude at the coordinates given on the map. If necessary, he corrects the altitude until elevation displayed at height display is within 10 feet of desired height or one-half contour interval. He then presses the ENTER LOCATION switch to enter the target in storage.

Hostile fire may be of such volume that the temporary storage is near capacity. Then the supervisor directs the operator to stop the radiating or to enter locations with low datum plane height to empty the display queue for new locations. The operator may later do height corrections when time is available. When the supervisor makes his decision, he must consider the tactical situation, counterbattery status, control headquarters guidance, EW environment, and length of time the radar has been radiating.

When required by the controlling headquarters, the operator sends the targets to the designated headquarters by digital message. All hostile fire locations are sent in the fire for effect format except when a hostile location outside the supported unit's area is made or when few counterfire targets are received. In these situations, the target intelligence format is used. If

TACFIRE is not available, target locations are sent by voice over radio or land line.

Procedures for sending a message to TACFIRE are in TM 11-5840-355-10-1, chapter 2, pages 2-246 through 2-249.

7-13. Friendly Fire Mode Operations

The three friendly fire modes are impact predict (adjustment of fire), datum plane registration (mean-point-of-impact registration), and airburst registration (high-burst registration). The specific type of mission is indicated by the FDC in the message to observer. The radar system is operated the same for all three friendly fire missions when the appropriate mode is selected.

Conduct of the Mission

The friendly fire parameters are entered into the radar set, and the desired mode of operation is selected. When the radar section is ready, the section reports READY TO OBSERVE to the FDC. Depending on the situation, the supervisor may elect to control the firing and/or request a splash notification from the FDC. Radiation periods must be minimized during radar registration/adjustments. The radar section chief coordinates with the FDC to establish procedures to minimize radiation time; e.g., FDC gives a

10-second SPLASH. The radar would radiate from SPLASH until it has a location and then go to standby. The radar section observes as rounds are fired and transmits the data for each round to FDC. When released by the FDC, the section acknowledges end of mission and returns to the hostile mode in either standby or radiating.

Duties of Personnel

SUPERVISOR/SENIOR RADAR OPERATOR. Receives, records, and acknowledges message to observer from FDC and verifies the completeness of the friendly fire parameters. He instructs the WLU operator to enter the friendly fire parameters. Once these are entered, the computer automatically determines pointing azimuth and frequency elevation. Then, the supervisor notifies the FDC that the section is ready to observe and gives any modifications to the method of fire that the section desires. He monitors the radar to insure that each round is tracked and data are recorded. He verifies end of mission when all observed data are sent to the FDC.

WEAPONS LOCATION UNIT OPERATOR. On direction of the supervisor, enters the friendly fire parameters, verifies that the radar accepted the data, and requests a printout of the parameters to verify their correctness. When the mission begins, he calls each round from queue and verifies that data are complete. If directed, he transmits the data to the FDC.

★ CHAPTER 8

DECONTAMINATION OF EQUIPMENT

	Paragraph
General	8-1
Chemical Decontamination	8-2
Biological Decontamination	8-3
Radiological Decontamination	8-4

8-1. General

This chapter discusses briefly the subject of decontamination of equipment. In order to understand precisely how to perform these operations, the radar section should become thoroughly familiar with the procedures outlined in TM 3-220 and FM 21-40.

Equipment that has been contaminated by chemical, biological, or radiological (CBR) agents must be decontaminated to reduce the hazard to personnel. Decontamination can be done by covering, removing, destroying, or changing into harmless substances the contaminating material. Personnel performing CBR decontamination should wear their masks and their normal clothing buttoned at the neck and tied at the wrists and ankles with string (trousers bloused). For added protection, personnel may wear any other protective items that are available.

8-2. Chemical Decontamination

The best method of decontaminating radar equipment is the use of hot air. The next best method is aeration or weathering. The metal parts exposed to blister and V-agents may be decontaminated with DS2, which is an excellent decontaminant for radar equipment. Also, it is readily available to the radar section. Normally, electrical devices that contain electron tubes or other heat-producing elements are decontaminated by the heat given off during operation.

8-3. Biological Decontamination

A decontaminant for destroying or removing contamination should be effective

against a variety of biological agents. Items currently available are natural and chemical decontaminants. Most decontaminants and procedures for chemical decontamination are effective for biological decontamination. Natural decontamination by rain, wind, and sunlight will destroy most biological agents on the exterior of equipment within a day. Ethylene oxide or carbonide may be used to decontaminate the interior of the equipment.

8-4. Radiological Decontamination

Decontaminants that have good cleansing characteristics normally are used for radiological decontamination, because the contaminants for fallout usually are finely divided particles that adhere closely to materials and tend to settle into pores and crevices. In most military situations, radiological contaminants are removed satisfactorily by flushing with water, by the use of steam, and by brushing. The use of DS2 for chemical decontamination of equipment also will remove most radiological contamination. When speed is not an important factor, aging is the most desirable method, since it will make laborious decontamination work unnecessary.

★ APPENDIX

REFERENCES

A-1. Army Regulations (AR)

(C) 105-2	Electronic Counter-Countermeasures (ECCM)— Electronic Warfare Susceptibility and Vulnerability (U)
(C) 105-3/AFR 55-3	Reporting Meaconing, Intrusion, Jamming, and Interference of Electromagnetic Systems (U)
(C) 105-87	Electronic Warfare (U)
310-25	Dictionary of United States Army Terms
530-1	Operations Security (OPSEC)
(C) 530-3	Electronic Security (U)
611-201	Enlisted Career Management Fields and Military Occupational Specialties
750-1	Army Material Maintenance Concepts and Policies

A-2. Field Manuals (FM)

5-15	Field Fortifications
5-20	Camouflage
5-25	Explosives and Demolitions
6-2	Field Artillery Survey
*6-13R	Soldier's Manual: 13R, Field Artillery Firefinder Radar Operator
6-17B	Soldier's Manual: 17B, Field Artillery Radar Crew Member
6-20	Fire Support in Combined Arms Operations
6-40	Field Artillery Cannon Gunnery
6-50	The Field Artillery Cannon Battery
6-121	Field Artillery Target Acquisition
21-6	How to Prepare and Conduct Military Training
21-11	First Aid for Soldiers
21-26	Map Reading
21-30	Military Symbols
21-31	Topographic Symbols
21-40	NBC (Nuclear, Biological, and Chemical) Defense
21-60	Visual Signals
22-5	Drill and Ceremonies
32-6	SIGSEC Techniques
(C) 32-20	Electronic Warfare (U)
55-30	Army Motor Transport Units and Operations

*To be published.

A-3. Technical Manuals (TM)

3-220	Chemical, Biological, and Radiological (CBR) Decontamination
5-2805-203-14	Operator, Organizational, DS, GS, and Depot Level Maintenance Manual: Engine, Gasoline, 6 HP (AN/TPS-25)
5-2805-203-24P	Organizational, DS, GS, and Depot Maintenance Repair Parts and Special Tool Lists for Engine, Gasoline, 6 HP (AN/TPS-25)
5-2805-257-14	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Engine, Gasoline, 3 HP
5-2805-258-14	Operator, Organizational, DS, and GS Maintenance Manual; Engine, Gasoline, 10 HP (AN/TPS-58)
5-2805-259-14	Operator, Organizational, DS, and GS Maintenance Manual; Engine, Gasoline, 20 HP (AN/TPS-58)
5-6115-271-14	Organizational, DS, GS and Depot Maintenance Manual; Generator Set, Gasoline Engine, 3 KW (Less Engine) 3 KW, AC, 400 Hertz (AN/TPS-25)
5-6115-271-24P	Organizational, Intermediate (Field) DS, GS and Depot Maintenance Repair Parts and Special Tools List for Generator Set, Gasoline Engine Driven, Skid Mounted, Tubular Frame, 3 KW, 3 Phase AC: 120/208 and 120/240, 60 Hz, 400 Hz, and 28 VDC (AN/TPS-25)
5-6115-323-14	Operator/Crew, Organizational, Intermediate DS, GS, and Depot Maintenance Manual: Generator Set, Gasoline Engine Driven, Skid Mounted, Tubular Frame 1.5 KW, Single Phase AC, 120/240 V, 28 VDC
5-6115-365-15	Operators, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts Generator Sets, Gasoline and Diesel Engine Driven, Trailer Mounted (AN/TPS-25)
*5-6115-545-12	Operator and Organizational Maintenance Manual: Generator Set, Diesel Engine Driven, Tactical Skid Mounted, 60 KW, 3 Phase, 4 Wire, 120/208 and 240/416 V, Utility Class, 50/60 Hz, Precise Class, 50/60 Hz, and Precise Class, 400 Hz
*5-6115-597-12	Operator and Organizational Maintenance Manual Generator, Portable, Gas Turbine Engine Driven, Skid Mounted, AC, 400 Hz, 10 KW: 120/208 Volts, 3-Phase, 4-Wire MEP-D423A
9-1300-200	Ammunition, General
11-5840-208-10	Operator's Manual for Radar Set AN/MPQ-4A
11-5840-217-10	Operator's Manual: Radar Sets AN/TPS-25, AN/TPS-25A and AN/TPS-25(XE-2)

*To be published.

11-5840-287-12	Operator's and Organizational Maintenance Manual: Simulator, Radar Target, Signal, AN/TPA-7
11-5840-348-12	Operator's and Organizational Maintenance Manual: Radar Set AN/TPS-58
*11-5840-354-10-1/2	Operator's Manual for Mortar Locating Radar AN/TPQ-36
*11-5840-354-20-1	Organizational Maintenance Manual (Functional Description and Maintenance) for Mortar Locating Radar AN/TPQ-36
*11-5840-354-20-2	Organizational Maintenance Manual (Antenna/Transceiver Removal and Installation Procedures) for Mortar Locating Radar AN/TPQ-36
*11-5840-355-10-1/2	Operator's Manual for Artillery Locating Radar AN/TPQ-37
*11-5840-355-20-1	Organizational Maintenance Manual for Artillery Locating Radar AN/TPQ-37
*11-5840-355-20-2	Organizational Maintenance Manual (Antenna Group Removal and Installation) for Artillery Locating Radar AN/TPQ-37
*11-5840-355-20-3	Organizational Maintenance Manual (Transceiver Removal and Installation) for Artillery Locating Radar AN/TPQ-37
*11-5840-364-20	Organizational Maintenance Manual for Operations Control Group OK-398/TPQ (Shelter)
11-6940-205-15	Operator's, Organizational, Field, and Depot Maintenance: Trainer Radar AN/ULT-T2 (AN/TPS-25)
11-6940-209-10	Operator's Manual: Radar Trainer AN/ULT-T5 (AN/MPQ-4A)
38-750	The Army Maintenance Management System (TAMMS)
55-450-11	Air Transport of Supplies and Equipment: Helicopter External Loads Rigged With Air Delivery Equipment
750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use

A-4. Tables of Organization and Equipment (TOE)

6-116	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Light Infantry Brigade
6-186	Headquarters and Headquarters Battery, Field Artillery Battalion, 105-mm, Towed, Separate Infantry Brigade

*To be published.

6-206	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm Towed, Airborne Division or Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Airborne Brigade
6-307	Target Acquisition Battery
6-376	Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Armored Brigade or Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Infantry Brigade (Mechanized)

A-5. Miscellaneous

ARTEP 6-307	Field Artillery Target Acquisition Battery (TAB)
DA Form 2407	Maintenance Request
DA Form 2888	Radar-Observed High-Burst or Mean-Point-of- Impact (Datum Plane) Registration
DA Pam 108-1	Index of Army Motion Pictures and Related Audio-Visual Aids
DA Pam 310 series	Index of Military Publications
TB 43-0116	Identification of Radioactive Items in the Army Supply System
TC 21-5-7	Training Management in Battalions
TF 6-3096	Counter mortar Radar AN/MPQ-4A (22 min)

RADAR-OBSERVED CENTER-OF-IMPACT REGISTRATION (AN/TPS 58)					For use of this form, see FM 6-161, the proponent agency is US Army Training and Doctrine Command.			
STEP ONE: Message to Observer			STEP TWO: Radar Pointing			STEP THREE: Report to FDC		
1. Observe CI			5. Pointing Azimuth			AT MY COMMAND REQUEST SPLASH (ready to observe)		
2. FOR (Unit or Call Sign)			6. Pointing Range					
3. AT GRID			7. Registration Point Alt					
3a. Reoriented Grid			8. Radar Altitude					
4. REPORT WHEN READY TO OBSERVE			9. Vertical Interval (7-8)					
			10. Elevation Angle (9 ÷ 6)					
STEP FOUR: Recording and Computations								
ROUND	Deviation Scope Data				L-Box Data			
	AZIMUTH		RANGE		Δ X		Δ Y	
	left —	right +	short —	over +	— Δ X	+ Δ X	— Δ Y	+ Δ Y
1.								
If required adjust pointing data and correct blocks 3,5,6.								
2.								
3.								
4.								
5.								
6.								
7.								
Total	—	+	—	+	—	+	—	+
Alg total	11		12		13		14	
	15 Azimuth Corr 6 (11) (Nearest 1m)		16 Range Corr 6 (12) (Nearest 10m)		17 Δ XCorr (13) (Nearest 10m)		18 Δ YCorr (14) (Nearest 10m)	
STEP FIVE: Coordinate Computation					STEP SIX: Report to FDC			
19. Registration Point Coordinates (3a)			Alternate Coordinate Computation Method		29. Report on radar observed			
			22. Pointing Range (6)					
			20. Δ X and Δ Y Corrections (17&18) Δ X Δ Y			23. Range Correction (16)		30. Time Observed
24. Range (Radar to Burst) (22 + 23)		31. Altitude (DID HIT)CI						
21. DID HIT Coordinates (19-20)						25. Pointing Azimuth (5)		32. Coordinates (21 or 28)
			26. Azimuth Correction (15)					
			27. Azimuth (Radar to Burst) (25 + 26)					
28. L Box Coordinates								

FM 6-161

27 JULY 1978

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Brigadier General, United States Army
The Adjutant General

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Field Manual

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 27 July 1978

No. 6-161

FIELD ARTILLERY RADAR SYSTEMS

This manual, *used in conjunction with the appropriate operator TMs*, is a guide for employing field artillery radar systems. It is directed toward the radar operator and his direct supervisor(s). Only those subjects not appropriately covered in other manuals are included.

The material presented herein applies, without modification, to both nuclear and nonnuclear warfare.

Change and Comments. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded directly to the Commandant, US Army Field Artillery School, ATTN: ATSF-TD-TM, Fort Sill, Oklahoma 73503.

References. Related publications are listed in the appendix.

*This publication supersedes FM 6-161, 30 July 1975; and FM 6-162, 12 March 1969.

The word "he" or "his" in this publication is intended to include both the masculine and feminine genders and any exception to this will be so noted.

FIELD ARTILLERY RADAR SYSTEMS

	Page
CHAPTER 1. The Threat	1-1
CHAPTER 2. Training	2-1
CHAPTER 3. Weapons Locating Radar Set AN/MPQ-4A	3-1
SECTION I. Organization	3-2
II. Registration	3-3
III. Radar Adjustment of Fire	3-21
IV. Radar Survey	3-24
V. Tactical Employment and Position Requirements	3-25
VI. Operations Security	3-30
VII. Airlifting the AN/MPQ-4A Radar and Ancillary Equipment	3-35

	Page
CHAPTER 4. Moving Target Locating Radar Set AN/TPS-25A	4-1
SECTION I. Organization and Operation	4-2
II. Tactical Employment and Position Requirements	4-3
III. Airlifting the AN/TPS-25A and Ancillary Equipment	4-15
CHAPTER 5. Moving Target Locating Radar Set AN/TPS-58	5-1
SECTION I. Organization and Operation	5-1
II. Target Acquisition and Radar Gunnery	5-2
CHAPTER 6. Decontamination of Equipment	6-1
APPENDIX References	A-1

CHAPTER 1

THE THREAT

Purpose and Scope	Paragraph 1-1
Characteristics of Field Artillery Radar	1-2
Operations Security Indicators	1-3
Countermeasures	1-4

1-1. Purpose and Scope

The purpose of this chapter is to describe the potential battlefield threat to radar survival, and to identify the operational security indicators and equipment shortcomings that must be eliminated or controlled to reduce this vulnerability.

1-2. Characteristics of Field Artillery Radars

There are several tactical radars that have been designed specifically to meet the targeting needs of field artillery (i.e., enemy indirect fire weapons and moving target location). These radars have been categorized as weapons locating or moving target locating radars.

Weapons Locating Radars

The AN/MPQ-4A is the current US Army weapons locating radar. It has been designed to

provide the coordinates of enemy indirect fire weapons at ranges up to 15,000 meters with an accuracy of 0 to 200 meters, depending upon the trajectory of the enemy rounds. The radar uses two beams (upper and lower) to detect the round. As the round passes through each beam, a reflected signal is received at the radar set. The range and direction to each intercept point provide the radar's computer with the information needed to compute the coordinates of the firing piece or the impact of the round, depending upon which leg (ascending or descending) of the trajectory the radar observes.

Moving Target Locating Radars

Moving target locating radars, such as the AN/TPS-25A and the AN/TPS-58, are designed to observe moving vehicles and personnel. Both the AN/TPS-25A and the AN/TPS-58 are doppler radars that provide the operator with the location of the target as well as some indication of the nature of the target (personnel, light truck, armored vehicles, etc.). The AN/TPS-58 is also capable of performing certain radar gunnery missions.

1-3. Operations Security Indicators

Operations security (OPSEC) is defined in AR 530-1 as the protection of military operations and activities through the identification and subsequent elimination or control of intelligence indicators that are susceptible to hostile exploitation. Indicators are anything that can be converted by the enemy into meaningful intelligence and are categorized as signatures, profiles, and patterns. Signatures are intelligence indicators that result from the presence of military equipment or personnel. Profiles are the indicators caused by the actions of a military unit. Patterns are the indicators caused by stereotyped actions.

Signatures can be controlled by the radar section. Profiles and patterns can be corrected only by the headquarters controlling the radars. This section will deal primarily with the signatures associated with FA radars. At the radar section level, little can be done to avoid operational patterns. Normally, FA radars are "cued" by the station they report to. It is the responsibility of commanders and staff officers to review employment procedures to reduce vulnerabilities arising from operational profiles and patterns.

There are four types of signatures—imagery, electromagnetic, olfactory, and sonic. The discussion below covers only the first two signature types, since radar sections are particularly vulnerable to exploitation through their imagery and electromagnetic signatures. FA radars present unique imagery and electromagnetic signatures. There are only a few FA radars within each division area of operations (in comparison to the number of other emitters within the division), and each radar can be tied to a field artillery command post (CP) at battalion or higher level through analysis of communications nets. Analysis of radar positions and the radio nets in which they operate can be the start point for an opposing force staff to break down the entire friendly artillery order of battle. This vulnerability must be kept in mind when employing FA radars.

IMAGERY SIGNATURES. The unique antennas on FA radar systems make them easy for imagery interpreters to recognize. This visual signature has to be overcome through careful use of terrain and camouflage techniques. The requirement to maintain electronic line of sight to the target or the enemy round (in the case of weapons locating radars) further complicates the problem of overcoming the visual signature problem. The radar, its generator, and associated vehicles produce large amounts of heat. This heat is the source of an infrared (IR) signature, which is another imagery signature. Care must be taken to reduce this signature through baffling or shielding. However, shielding, which significantly reduces the infrared signature, may well heat the equipment beyond its design limits, inducing equipment failure. On the other hand, an infrared signature behind the first hill can be fully exploited only by an aerial platform that goes over the radar position. This reduces, somewhat, a potential enemy's capability to exploit this signature.

ELECTROMAGNETIC SIGNATURE. Electromagnetic signature is normally what is envisioned when radar signature is discussed. An enormous amount of information can be gained from the analysis of a radar's signal. The radar's signal characteristics—frequency, bandwidth, pulse width, and pulse repetition frequency—are unique to each type of radar. An enemy intercept operator can readily tell when he has an AN/MPQ-4A, an AN/TPS-25, or an AN/TPQ-58.

A potential enemy would use the technique of direction finding (DF) to locate radars. The information that cannot be gained from signal analysis is gained through direction finding. Direction finding is accomplished by monitoring an emitter with three or more receivers simultaneously. Each receiver is fitted with a steerable, highly directional antenna. The orientation of the antenna gives a line bearing to the receiver. The intersection of the three bearing lines gives the transmitter's location. This technique is used to locate both radios and radars. **However, because of the physical characteris-**

tics of radio waves at various frequencies, improperly employed radars can be located within 50 to 100 meters; whereas, the location of a tactical radio set within 250 meters is considered highly accurate.

The radar's electromagnetic signature is its greatest vulnerability. Through signal analysis, enemy intercept operators can identify the type of radar employed. Knowledge of US employment practices and organization tells the intercept operator which artillery organizations this radar section might report to (e.g., battalion FDC, div arty TOC). Direction finding of the radar signal would locate the radar set. Intercept and direction finding of the radar section's tactical radio key the intercept operator to the net in which the radar section is operating. The next step is to locate and find the direction of the station to which the radar section reports. Finally, by intercepting the many other nets an

artillery headquarters must operate in and confirming that all of these emitters are tied to a single location, the command post location is confirmed. The association of radios and radars provides enemy intelligence analysts a lucrative source of information on the friendly forces order of battle.

1-4. Countermeasures

The actions that can be taken by the radar section to reduce its imagery and electromagnetic signatures (thereby increasing its survivability) are discussed in chapter 3, section VI, and chapters 4 and 5, or in the applicable equipment technical manual.



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CHAPTER 2

TRAINING

	Paragraph
Purpose and Scope	2-1
Objective	2-2
Planning	2-3
Training Considerations	2-4
Conduct of Training	2-5
Training Resources	2-6
Summary	2-7

2-1. Purpose and Scope

The purpose of this chapter is to present the requirements for training the personnel of a radar section in the performance of their duties. It includes general and specific guidelines on how this training will be conducted.

2-2. Objective

The primary objective is to train the radar crewmen individually to meet the standards of Soldier's Manual FM 6-17B and the radar sections collectively to meet those outlined in ARTEP 6-307, with combat effectiveness as an

end result. Once attained, this proficiency level can be maintained only by frequent, imaginative, and meaningful follow-on training.

2-3. Planning

Evaluation

The first step in the planning process is to evaluate the section/individual training strengths and weaknesses as they relate to the tasks identified in the ARTEP. The results of this evaluation process are the basis for the development of a training program. The training objective, identified during evaluation, must then be prioritized and incorporated into the platoon's individual and section training plan.

Resource Requirements

The next step is to insure that all existing or required resources are available to conduct a successful training program. These include:

INSTRUCTORS.
EQUIPMENT.
TRAINING AIDS (e.g., SIMULATORS AND FILMS).
TRAINING AREA/ENVIRONMENT.
TIME.
EXTERNAL SUPPORT (e.g., LIVE FIRE AND COMMUNICATIONS).

The end result of training—individual and collective—is combat effectiveness.

Alternatives

Finally, it is necessary to provide for a fallback position if the optimum training plan cannot be implemented. The one factor that will disrupt training the most is the nonavailability of radar personnel or equipment as the result of unscheduled commitments. Another is changes in the weather conditions. In any event, careful planning that provides an alternative to continue training under other than optimum conditions is essential if the overall program is to succeed. Trainers must use every available precious resource and every training opportunity offered to maintain and enhance the combat readiness of personnel and sections.

2-4. Training Considerations

The only limiting factor to the success or failure of a training program is the imagination and ingenuity of the trainer. He must conduct a flexible and realistic program oriented toward performance, rather than procedure, with a built-in system of periodic evaluations to measure and modify the program as required.

The program should include training at the lowest level identified in the evaluation pro-

cess. As individual crewmen become proficient, section training must follow to integrate the individual skills into the collective effort. Multilevel training should be conducted concurrently whenever possible.

Every opportunity to conduct or participate in training must be thoroughly investigated to insure that maximum use is made of available training resources. Integrated training commitments to support division artillery units with radar sections are particularly desirable and necessary to develop proficiency in working with the fire direction center (FDC) and tactical operations center (TOC) and should be energetically solicited and accepted whenever they are offered.

The impact of training cost must be considered in light of an always austere budgetary environment and, more importantly, conservation of the limited supplies available. Maximum training must be accomplished with each live round fired. In all cases, training devices or simulators should be used whenever live fire support is not required.

2-5. Conduct of Training

Training will be conducted in accordance with TC 21-5-7 and FM 21-6. The goal of training must be the standards set forth in AR 611-201, ARTEP 6-307, and Soldier's Manual FM 6-17B.

Normally, individual training is conducted by noncommissioned officers, as far as practicable. Officers are responsible for preparing training plans, for conducting unit training, and for supervising and testing individual training.

An informal record, reflecting all training received by each individual in the section, is maintained by the section chief or the field artillery radar technician. This record shows each period of instruction attended, tests taken, and pertinent remarks that describe the training status of the individual. Collectively, these individual records serve as a ready reference to determine the radar section's status of training.

2-6. Training Resources

The soldier's manual (SM) is a field manual for the individual soldier that defines for him in "real world terms" what the Army requires him to know and do throughout his career in his MOS. Soldier's manuals provide individual tasks, conditions, standards, and the references that apply and are the prime source from which skill qualification tests (SQT) are developed.

The commander's manual (CM) provides a complete list of critical tasks for each MOS from skill level 1 to 4. The list identifies tasks, gives references, and indicates where a soldier is trained for the task. Commander's manuals are an invaluable aid for both trainers and managers.

The skill qualification test determines the soldier's proficiency at his current skill level and his qualifications for advancement to the next higher skill level. The skill qualification test emphasizes hands-on performance rather than written tests. Using SQT results, the training manager and trainer can determine individual training weaknesses.

Training support material includes:

FIELD ARTILLERY CATALOG OF INSTRUCTIONAL MATERIAL. This document is published annually and contains a listing of all instructional material available for issue to units in the field. Requests for copies of the catalog should be addressed to: Commandant, US Army Field Artillery School, ATTN: ATSF-CR-TS, Fort Sill, OK 73503.

FIELD ARTILLERY RADAR CREWMAN INSTRUCTIONAL PACKET. This is a packet of training material to supplement training of MOS 17B10/20 and is available from the same source as that listed above.

The Training and Audiovisual Support Center (TASC) can provide the training manager and the trainer all types of audiovisual aids, graphic training aids, training devices, training room support items, and training equipment. Each TASC publishes a catalog that lists what is available and gives instructions on how to request the items.

**Radar-related devices
normally available at
TASC:**

**AN/TPA-7
AN/ULT-T5
AN/ULT-T2**

MORTAR LOCATING RADAR TARGET SIMULATOR AN/TPA-7 (TASO DEVICE NO: DVC X15B1). Use of this training device is the most effective method of conducting weapons locating and gunnery training on the AN/MPQ-4A when live fire support is not available.

TRAINER, RADAR AN/ULT-T5 (TASO DEVICE NO: DVC 11-35). Operating the AN/MPQ-4A radar set in an electronic warfare environment involves special preparatory training. The radar crewman must actually experience the jamming and interference signals to develop proficiency in recognition and application of remedial techniques. This device generates all of the various electronic countermeasure (ECM) signals encountered and emphasizes the existence of a hostile environment.

COUNTERMEASURES TRAINING SIGNAL TRANSMITTING SET AN/ULT-T2 (TASO DEVICE NO: DVC 11-7). This simulator performs the same functions for the radar set AN/TPS-25A as the AN/ULT-T5 does for the A/MPQ-4A.

2-7. Summary

It is an established fact that one of the dividends of a vigorous, realistic, and effective training program is an increased ability to survive during combat operations. Exceptional single-mindedness of purpose, innovativeness, and tenacity are required to overcome the many obstacles that may delay, defer, or dilute the best laid plans for conducting radar training.

Two of the most important factors to be considered when determining a radar section's ability to survive during hostile environment operations are its proficiency in, and the degree of discipline it demonstrates toward, security, camouflage, and electronic counter-countermeasures. These essential elements must be incorporated into every training exercise to the greatest degree possible. The radar section must not be allowed to become complacent in training, or they may not survive in combat.

Field Artillery Radar Mechanic

Performs organizational maintenance of radar equipment and assists the radar technician.

Senior Field Artillery Radar Operator

Operates and supervises the operation of the radar set, assists in the emplacement and concealment of the radar position, and assists the section chief in all of his duties.

Radar Operator

Operates the radar and the computer, using the controls of the control-indicator group.

Sets up the radar chart on a grid sheet, determines the altitudes of the weapon locations from a contour map, plots the final locations, and keeps the necessary records.

Operates the radar's prime movers and performs scheduled maintenance on the prime movers. Provides local security and performs other duties assigned by the chief of the section.

Operates, and performs user maintenance on, communications equipment utilized in the radar section.

Power Generator Operator/Mechanic

Operates and performs operator and organizational maintenance on the power generator; provides local security; and assists in the operation of the radar set during periods of intense enemy weapons activity.

3-3. Organization of Personnel for Operation

A well-trained radar crew is essential to insure accurate and timely locations of hostile weapons. Continuous operation may be required during combat; therefore, every man in the section must be capable of performing each of the duties necessary to obtain and process hostile weapon locations.

During continuous operation, the section should be organized into three-man teams, excluding the chief of section and the radar repairman, who are on call continuously. These three-man teams must consist of a radar operator, a radar plotter, and a generator operator.

To prevent fatigue and eyestrain, the members of the team should alternate their duties so that no one member serves as the control unit operator more than 30 minutes at a time. When the teams are changed, the personnel on duty should be relieved one at a time. This will allow each person to become familiar with the situation as he assumes his duty, since he will be working with two men who are already familiar with the situation.

Note. Weapon location procedures are found in TM 11-5840-208-10.

Section II. REGISTRATION**3-4. Purpose**

The firing tables used by field artillery units are based on a set of standard conditions of weather and materiel. If all conditions of weather and materiel are standard and there are no errors in survey or in the firing chart, a projectile will achieve the standard range defined in the appropriate firing table and burst on the gun-target

line. However, standard conditions of weather and materiel seldom exist simultaneously; therefore, a projectile rarely (if ever) hits the target when a weapon is fired with only standard firing table data. Nonstandard atmospheric conditions, nonstandard materiel, or errors in survey or in the firing chart may cause inaccuracy in firing.

Notes.

1. (High burst only) The telescope must be oriented to the pointing azimuth. To accomplish this, place the DETENT switch in the AZIMUTH ORIENT position. Apply (add or subtract as necessary) the field correction to the chart azimuth. Then move the antenna in azimuth until the AZIMUTH counter indicates the corrected value. Record the chart azimuth in block 6 of DA Form 2888.
2. If the burst from the first round appears above the horizon, but is not seen on the B-scope, the pointing angle of elevation must be changed to cause the next round to burst in the radar beam. The antenna also may have to be moved in azimuth to cause the burst to appear in the center of the telescope. When the antenna is moved in azimuth or elevation, the new pointing data must be entered in the appropriate block under step 2 of DA Form 2888. If the first round bursts more than 5 mils below the center of the telescope, the FDC must be notified (BURST TOO LOW, REQUEST SITE (altitude) INCREASE). The antenna should never be lowered in elevation.
3. (High burst only) If the B-scope azimuth disagrees with the telescope azimuth more than -10 mils, an error has been made in spotting, marking, or strobing the echo on the B-scope. Therefore, the data to the round will not be valid.
4. The average azimuth, range, and altitude must be computed independently by two crewmembers. Insert the average azimuth and range into the computer. Record the resulting grid coordinates in block 41, DA Form 2888. Polar-plot the average range and azimuth on the radar chart and record the resulting grid coordinates. These two sets of coordinates should agree with each other within 20 meters in easting and 20 meters in northing.

RADAR OBSERVED HIGH-BURST OR MEAN POINT-OF-IMPACT (DATUM PLANE) REGISTRATION For use of this form, see FM 6-161; the proponent agency is TRADOC.				SEE NOTES ON REVERSE			
STEP 1 MESSAGE TO OBSERVER				STEP 2: INITIAL POINTING DATA		STEP 3 INITIAL REGISTRATION POINT ALTITUDE	
1 OBSERVE (Check applicable box) ☒ HB ☐ MPI				6. AZ (Nearest 1 mil) (Note 1) 1639 + 45 = 1679		11 MAP ALTITUDE 340 + 50 meters = 390	
2 FOR (Unit or call sign) 24B42				7. RANGE (Nearest 10 meters) 6110		12 RANGE (7) (in thousands) 6.11	
3. AT GRID 6400 3900				8. ELEV TO SC CR 1.6		13. ELEVATION (10) 26	
4. REPORT ALTITUDE				9. +10 MIL +10		14 VI (12 x 13) 159	
5. REPORT WHEN READY TO OBSERVE				10. ELEV (Nearest 1 mil) (B + 9) 26 + 7 = 33		15 ALTITUDE (RADAR) (Meters) 326	
						16 ALTITUDE (RP) (14 + 15) 485	
STEP 4 REPORT TO FDC							
ALTITUDE (16 or 11 whichever is the greater) 485							
AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE							
STEP 5 RECORDING AND COMPUTATION							
ROUND NO.	FROM B SCOPE		FROM TELESCOPE (HIGH BURST ONLY)				
	RANGE	AZIMUTH	AZIMUTH DEVIATION (Note 3)		ELEVATION DEVIATION		
			LEFT (-)	RIGHT (+)	BELOW (-)	ABOVE (+)	
1	6300	1675		0 45		0 7	
IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 6 AND 10 (Note 2)							
2	6280	1675		4	6		
3	6250	1672		5	5		
4	6340	1680		7		1	
5	6320	1677		25	0		
6	6290	1675		7	2		
7	6000	1650	25			19	
8	6220	1680		7	6		
TOTAL	37680	18.	TOTAL LEFT (-) -7	TOTAL RIGHT (+) +23	TOTAL BELOW (-) -19	TOTAL ABOVE (+) +1	
NOTE AFTER SIX VALID ROUNDS REPORT "END OF MISSION" TO FDC			19 AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (-) AND RIGHT (+) +16		20 ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (-) AND ABOVE (+) -18		
23 REGISTRATION POINT RANGE (Nearest 10 meters) 6280 6 37680 (17) 6280		24 AZIMUTH OF MPI (Nearest 1 mil) NOT USED (18)		21 0 2.6 6 +16 (19)		22 0 3 6 -18 (20)	
				25 (21) +3		27 (22) -3	
				26 (6) 1679		28 (10) 33	
				29 HB AZ (Algebraically add 25 and 26) 1682		30 HB ELEV (Algebraically add 27 and 28) 30	
STEP 6 FINAL REGISTRATION POINT ALTITUDE				STEP 7 REPORT TO FDC			
31 RP RG (23) (in thousands) 6.280				36 REPORT ON RADAR OBSERVED (Check applicable box) ☒ HB ☐ MPI			
32 HB (Enter value block (30)) MPI (Enter value block (10)) 30				37 TIME OBSERVED 261500			
33 VI (31 x 32) 188				38 AZIMUTH (MPI (24) HB (29)) (See note 4) 1682			
34 ALTITUDE RADAR 326				39 RANGE (23) (See note 4) 6280			
35 ALTITUDE RP (33 + 34) 514				40 ALTITUDE (35) (See note 4) 514			
				41 GRID OF RP (Nearest 10 meters) 6414 3866			

DA FORM 2888

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

FOLDOUT FOR FIGURE 3-1, DA FORM 2888. THIS FORM SHOULD REMAIN VISIBLE FOR REFERENCE THROUGHOUT SECTION II.

The distance by which a projectile misses the target is caused by the combined effects of these errors. The total error and the corrections for it can be determined by registration.

In order to determine the corrections to compensate for nonstandard conditions, it is necessary to know where the rounds did hit when they were fired with a certain deflection, fuze setting, and quadrant elevation. The "did hit" location can be compared with the location where the rounds should have hit if all conditions had been standard. The difference between the "should hit" location and the "did hit" location can be converted to corrections by established procedures.

Normally, a mean-point-of-impact (MPI) or high-burst (HB) radar registration is faster and more economical than a precision registration conducted by a ground observer. From six usable observed rounds fired in a high-burst registration, the fire direction center (FDC) can determine the corrections to the firing data for deflection, fuze setting, and quadrant elevation. In a mean-point-of-impact registration, the same number of usable rounds are fired, but point-detonating fuzes are used; therefore, a correction for the fuze setting cannot be obtained. Normally, the FDC will fire a high-burst registration when the mechanical time fuze is available and its use is anticipated for subsequent fire missions in the area. (Registration may be conducted using only three usable rounds as determined by the fire direction officer (FDO).)

3-5. Radar as the Observer

The AN/MPQ-4A radar section is often required to observe high-burst and mean-point-of-impact registrations. The radar section should have direct communications with the FDC at all times. The radar section can complete a registration quickly, even during periods of poor visibility when ground observation is ineffective.

The radar visibility diagram (para 3-26) is used by the fire direction officer to select a suitable location for the registration. Initially, using the visibility diagram, he selects an observable area within range of the radar; a suitable altitude can then be determined by checking the screening crest profile.

3-6. Radar-Observed High-Burst Registration

A high-burst registration is fired with a mechanical time fuze. The burst must be high enough in space so that it can be observed through the optical telescope. The radar section is alerted to observe a high-burst registration by a message to observer. This message must be prepared by the FDC and sent to the radar sections. The radar section immediately plots the coordinates announced in the message to observer.

Figure 3-1. DA Form 2888 showing a completed high-burst registration.

Conduct of Fire

When the radar section is notified that the weapon is ready to fire, the radar plotter sends the command to fire the first round. When the weapon has fired, the FDC transmits SHOT, OVER to the radar section. The radar plotter acknowledges this report by transmitting SHOT, OUT to the fire direction center. Ten seconds before the round is due to burst, the FDC transmits SPLASH, OVER to the radar section. The radar plotter acknowledges this report by transmitting SPLASH, OUT to the fire direction center. When the radar section is ready for another round, it sends the command REPEAT to the fire direction center. The first round fired in a high-burst registration normally is considered an orienting round, and the radar crew may have to reorient the antenna on the actual burst point of the round. If it is necessary to reorient the antenna, the command REPEAT is delayed until the antenna has been reoriented and until after the previous round is recorded. The antenna is then reoriented to the actual burst point of the round. **THIS ROUND IS NOW CONSIDERED A VALID ROUND WITH 0-0 ERROR**, and the initial pointing data are changed to reflect the new pointing data.

Criteria for Use of Rounds

This procedure is continued until the radar section has observed and recorded on DA Form 2888 the data for six usable rounds. Usable rounds should burst within 50 meters of the rest of the rounds.

Location of High Burst

The radar can provide the location of the high burst either by grid coordinates and altitude; by direction, distance, and altitude from the radar to the high burst; or by direction, distance, and vertical angle to each round of the high burst. There is no difference in the accuracy of these three methods; however, the coordinates and altitude method is fastest because it does not require that the radar be plotted on the firing chart, and it is the preferred method of reporting. After the registration has been observed and any erratic round has been eliminated, the radar section transmits END OF MISSION to the fire direction center.

Note. Direction, distance, and altitude must *not* be sent in the clear.

Note 1.

(High burst only) The telescope must be oriented to the pointing azimuth. To accomplish this, place the DETENT switch in the AZIMUTH ORIENT position. Apply (add or subtract as necessary) the field correction to the chart azimuth. Then move the antenna in azimuth until the AZIMUTH counter indicates the corrected value. Record the chart azimuth in block 6 of DA Form 2888.

STEP 2: INITIAL POINTING DATA	
6. AZ (Nearest 1 mil) (Note 1)	$1634 + 45 = 1679$
7. RANGE (Nearest 10 meters)	6110
8. ELEV TO SC CR	18
9. +10 MIL	$+10$
10. ELEV (Nearest 1mil) (8 + 9)	$26 + 7 = 33$

IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 6 AND 10 (Note 2)						
2	6280	1675		4	6	
3	6250	1672		5	5	
4	6340	1680		7		1
5	6320	1677		25	0	
6	6290	1675		7	2	
7	6000	1650	25			19
8	6220	1680		7	6	
TOTAL	¹⁷ 37680	¹⁸	TOTAL LEFT (-)	TOTAL RIGHT (+)	TOTAL BELOW (-)	TOTAL ABOVE (+)
			-7	+23	-19	+1
NOTE AFTER SIX VALID ROUNDS REPORT END OF MISSION TO FDC			19 AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (-) AND RIGHT (+)		20 ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (-) AND ABOVE (+)	

Note 2.

If the burst from the first round appears above the horizon, but is not seen on the B-scope, the pointing angle of elevation must be changed to cause the next round to burst in the radar beam. The antenna also may have to be moved in azimuth to cause the burst to appear in the center of the telescope. When the antenna is moved in

azimuth or elevation, the new pointing data must be entered in the appropriate block under step 2 of DA Form 2888. If the first round bursts more than 5 mils below the center of the telescope, the FDC must be notified (BURST TOO LOW, REQUEST SITE (altitude) INCREASE). The antenna should never be lowered in elevation.

Note 3.

(High burst only) If the B-scope azimuth disagrees with the telescope azimuth more than -10 mils, an error has been made in spotting, marking, or strobing the echo on the B-scope. Therefore, the data to the round will not be valid.

AZIMUTH DEVIATION (Note 3)	
LEFT (-)	RIGHT (+)
0	75

Note 4.

The average azimuth, range, and altitude must be computed independently by two crewmembers. Insert the average azimuth and range into the computer. Record the resulting grid coordinates in block 41, DA Form 2888. Polar-plot the average range and azimuth on the radar chart and record the resulting grid coordinates. These two sets of coordinates should agree with each other within 20 meters in easting and 20 meters in northing.

38 AZIMUTH (MPI (24) HB (29)) (See note 4)	1682
39 RANGE (23) (See note 4)	6280
40 ALTITUDE (45) (See note 4)	514
41 GRID OF RP (Nearest 10 meters)	6414 3866

CHAPTER 4

MOVING TARGET LOCATING RADAR SET AN/TPS-25A

	Paragraph		Paragraph
Section I. Organization and Operation		Technical Considerations	4-7
Organization of Moving Target Locating Radar Section	4-1	Site Evaluation	4-8
Duties of Personnel	4-2		
Organization of Personnel for Operation	4-3	Section III. Airlifting the AN/TPS-25A and Ancillary Equipment	
		Airlifting Radar Set AN/TPS-25A	4-9
Section II. Tactical Employment and Position Requirements		Rigging the Shelter	4-10
General	4-4	Derigging the Shelter	4-11
Selection of Radar Site	4-5	Airlifting Radar Set AN/TPS-25A Shelter in Trailer	4-12
Tactical Considerations	4-6	Rigging the Load	4-13

Section I. ORGANIZATION AND OPERATION

4-1. Organization of Moving Target Locating Radar Section

There is one AN/TPS-25A or AN/TPS-58 radar section in each target acquisition battery. The AN/TPS-25 has a seven-man crew. Normally, the division artillery tactical operation center (TOC) will site and control the operation of the radar. To reduce the radar's vulnerability (it is an active transmitter) and to increase its effectiveness, the division artillery TOC will dictate when it is to radiate and the area it is to be oriented toward.

4-2. Duties of Personnel

The principal duties of personnel in a moving target locating radar section of a target acquisition battery are listed below:

Radar Technician

Advises commander and staff on equipment capabilities and employment. Performs reconnaissance to determine actual site. Coordinates the activities of all radar personnel in their respective duties.

Section Chief

Supervises operation and maintenance of the radar equipment, assists the radar technician, and evaluates site after occupation of position.

Field Artillery Radar Mechanic

Performs organizational maintenance and repair of radar equipment and assists the radar technician.

Senior Field Artillery Radar Operator

Operates and supervises the operation of the radar set, assists in the emplacement and concealment of the radar, and assists the section chief in all of his duties.

Radar Operator (Two)

Operates the radar using the controls on the radar set control unit.

Operates and performs user maintenance on communication equipment utilized in the radar section.

Operates the radar's prime movers and performs scheduled maintenance on the prime movers. Provides local security and performs other duties assigned by the chief of section.

Power Generator Operator/Mechanic

Operates and performs operator and organizational maintenance on the power generator, provides local security, and assists in the operation of the radar set during periods of intense enemy weapons activity.

4-3. Organization of Personnel for Operation

A well-trained crew is essential to insure accurate and timely location of enemy targets. Continuous operation may be required during combat; therefore, every man in the section must be capable of performing each of the duties necessary to obtain and process enemy targets.

During continuous operation, the section should be organized into two-man teams. To prevent fatigue, the team members should alternate their duties so that no one individual serves as control unit operator for more than 30 minutes at

CHAPTER 6

DECONTAMINATION OF EQUIPMENT

General	6-1
Chemical Decontamination	6-2
Biological Decontamination	6-3
Radiological Decontamination	6-4

6-1. General

This chapter discusses briefly the subject of decontamination of equipment. In order to understand precisely how to perform these operations, the radar section should become thoroughly familiar with the procedures outlined in TM 3-220, TM 3-225, and FM 21-40.

Equipment that has been contaminated by chemical, biological, or radiological (CBR) agents must be decontaminated to reduce the hazard to personnel. Decontamination can be done by covering, removing, destroying, or changing into harmless substances the contaminating material. Personnel performing CBR decontamination should wear their masks and their normal clothing buttoned at the neck and tied at the wrists and ankles with string (trousers bloused). For added protection, personnel may wear any other protective items that are available.

6-2. Chemical Decontamination

The best method of decontaminating radar equipment is the use of hot air. The next best method is aeration or weathering. The metal parts exposed to blister and V-agents may be decontaminated with DS2, which is an excellent decontaminant for radar equipment. Also, it is readily available to the radar section. Normally, electrical devices that contain electron tubes or other heat-producing elements are decontaminated by the heat given off during operation.

6-3. Biological Decontamination

A decontaminant for destroying or removing contamination should be effective against a variety of biological agents. Items currently

available are natural and chemical decontaminants. Most decontaminants and procedures for chemical decontamination are effective for biological decontamination. Natural decontamination by rain, wind, and sunlight will destroy most biological agents on the exterior of equipment within a day. Ethylene oxide or carbonide may be used to decontaminate the interior of the equipment.

6-4. Radiological Decontamination

Decontaminants that have good cleansing characteristics normally are used for radiological decontamination, because the contaminants for fallout usually are finely divided particles that adhere closely to materials and tend to settle into pores and crevices. In most military situations, radiological contaminants are removed satisfactorily by flushing with water, by the use of steam, and by brushing. The use of DS2 for chemical decontamination of equipment also will remove most radiological contamination. When speed is not an important factor, aging is the most desirable method, since it will make laborious decontamination work unnecessary.

APPENDIX REFERENCES

A-1. *Army Regulations (AR)*

(C) 105-2	Electronic Counter-Countermeasures (ECCM) (Including Electronic Warfare Susceptibility and Vulnerability) (U)
(C) 105-3/AFR 55-3	Report Meaconing, Intrusion, Jamming, and Interference of Electromagnetic Systems (U)
(C) 105-87	Electronic Warfare (U)
310-25	Dictionary of United States Army Terms
(C) 530-1	Operational Security (OPSEC) (U)
(C) 530-3	Electronic Security (ELSEC) (U)
611-201	Personnel Selection and Classification
750-1	Army Material Maintenance Concepts and Policies

A-2. *Field Manuals (FM)*

5-15	Field Fortifications
5-20	Camouflage
5-25	Explosives and Demolitions
6-2	Field Artillery Survey
6-20	Fire Support in Combined Arms Operations
6-40	Field Artillery Cannon Gunnery
6-40-5	Modern Battlefield Cannon Gunnery
6-50	The Field Artillery Cannon Battery
6-121	Field Artillery Target Acquisition
6-140	Field Artillery Organizations
21-11	First Aid for Soldiers
21-26	Map Reading
21-30	Military Symbols
21-31	Topographical Symbols
21-40	Chemical, Biological, Radiological, and Nuclear Defense

21-60	Visual Signals
22-5	Drill and Ceremonies
(C) 31-40	Tactical Cover and Deception (U)
32-6	SIGSEC Techniques
(C) 32-20	Electronic Warfare (U)
55-30	Army Motor Transport Operations

A-3. *Technical Manuals (TM)*

3-220	Chemical, Biological, and Radiological Decontamination
5-2805-203-14	Organizational, DS and GS, Maintenance Manual: Engine, Gasoline; Military standard Models (models 4A032-11) FSN 2805-776-0483 and (model 4A032-11) FSN 2805-068-7512 (AN/TPS-25)
5-2805-203-24P	Organizational, DS and GS, Maintenance Repair Parts and Special Tool Lists: Engine, Gasoline, Military Standard Models (model 4A032-1) FSN 2805-776-0483, (model 4A032-11) FSN 2805-068-7512 (AN/TPS-25)
5-2805-257-14	Operator, Organizational, Direct Support and General Support Maintenance Manual: Engine, Gasoline, 3 HP Military Standard models (model 2A016-1, FSN 2805-601-5127); (model 2A016-2, FSN 2805-714-8553); (model 2A016-3, FSN 2805-072-4871). (To 38G2-103-2; TM 03521A) changes 2, 3
5-2805-258-14; 259-14	Organizational, DS and GS Maintenance Manual; Engine, Gasoline, Military Standard Models (AN/MPQ-4A) (AN/TPS-58)
5-6115-271-14	Organizational, DS, GS and Depot Maintenance Manual; Generator Set, Gasoline Engine, 3 KW (Less Engine) 3KW, AC, 400 Hertz (AN/TPS-25)
5-6115-271-24P	Organizational, DS, GS and Depot Maintenance Repair Parts and Special Tools; Generator Set, Gasoline Engine, 3KW (Less Engine), 3 KW AC, 400 Hertz (AN/TPS-25)
5-6115-323-14	Operator, Organizational, DS, GS, and Depot Maintenance Manual including repair parts and special tool lists: Generator Set, Gasoline, Engine Driven, Air-cooled, Skid Shock mtd, tubular frame (less engine), Military Design 1.5 KW, ac,

	60 Hertz (DOD model-MEP-015A) FSN 6115-889-1446 and Military Design 1.5 KW dc, 28 Volt (DOD model MEP-025A) FSN 6115-017-8230 (to 35C2-385-11) changes 3, 4 (AN/TPS-58)
5-6115-365-15	Organizational, DS, GS, and Depot Maintenance Manual. Including Repair Parts Generator Sets, Gasoline and Diesel Engine Driven, Trailer Mounted (AN/TPS-25)
5-6115-450-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Generator Set, Gasoline Engine: 10-KW, AC 120/240 V, Single Phase; 120/208 V, 3-Phase, 400-Hertz, Skid-Mounted (Less engine) (Military Design Model MEP-023A) (AN/MPQ-4)
9-1300-200	Ammunition, General
11-5840-208-ESC	Equipment serviceability criteria for radar set AN/MPQ-4A
11-5840-208-10	Operator's Manual: Radar Set AN/MPQ-4A
11-5840-217-10	Operator's Manual: Radar Sets AN/TPS-25, AN/TPS-25A and AN/TPS-25 (XE-2)
11-5840-217-ESC	Equipment Serviceability Criteria for Radar Sets AN/TPS-25, AN/TPS-25A, and AN/TPS-25 (XE-2)
11-5840-287-12	Operator and Organizational Maintenance Manual: Simulator, Radar Target Signal AN/TPA-7
11-5840-348-12	Operator and Organizational Maintenance Manual: Radar Set AN/TPS-58
11-6940-205-15	Operator's Organizational, Field and Depot Maintenance: Trainer Radar AN/ULT-T2 (AN/TPS-25)
11-6940-209-10	Operator's Manual: Radar Trainer AN/ULT-T5 (AN/MPQ-4A)
38-750	Army Maintenance Management Systems (TAMMS)
55-450-11	Air Transportation of Supplies and Equipment: Helicopter External Loads Rigged with Aerial Delivery Equipment
750-244-2	Procedures for Destruction of Electronics Material to Prevent Enemy use (Electronics Command)

A-4. Tables of Organization and Equipment (TOE)

6-116	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Light Infantry Brigade
6-186	Headquarters and Headquarters Battery, Field Artillery Battalion, 105-mm, Towed, Separate Infantry Brigade
6-216	Headquarters, Headquarters and Service Battery, Field Artillery Battalion (105-mm towed), Airborne Division or Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Airborne Bde
6-307	Field Artillery Target Acquisition Btry
6-376	Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Armored Brigade or Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Infantry Brigade (Mechanized)

A-5. Miscellaneous

ARTEP 6-307	Field Artillery Target Acquisition Battery
DA Form 2407	Maintenance Request
DA Form 2888	Radar-Observed High-Burst or Mean- Point-of-Impact (Datum Plane) Registration, AN/MPQ-4A
	Radar-Observed Center of Impact Registration (AN/TPS-58)
DA Pam 108-1	Index of Army Motion Pictures and Related Audio-Visual Aids
DA Pam 310 series	Index of Military Publications
TB 43-0116	Identification of Radioactive Items in the Army Supply System
TC 21-5-7	Training Management in Battalions
TC 30-1	Tactical Cover and Deception
TF 6-3096	Countermortar Radar AN/MPQ-4A (22 min)





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